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SKINNER LANDFILL

West Chester, Butler County, Ohio

Remedial Design

Groundwater Design Investigation

Volume I of III

November 9, 1995

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SKINNER LANDFILL
REMEDIAL DESIGN

GROUNDWATER
DESIGN INVESTIGATION

WEST CHESTER, BUTLER COUNTY, OHIO

Rust Environment & Infrastructure Inc.
PROJECT NO. 72680.300

June 1, 1995

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Revision: 1

Skinner Landfill
Remedial Design
Groundwater Design Investigation

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DEFINITION OF TERMS AND ACRONYMS

AOC	Adminstrative Order on Consent
BOD	Biochemical Oxygen Demand
CAS No.	Chemical Abstract Services Number
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
cm/sec	centimeters per second
COD	Chemical Oxygen Demand
CRDL	Contract Required Detection Limit (equivalent to PQL)
DNAPL	Dense Non-Aqueous Phase Liquids
DSW	Division of Surface Water
FSP	Field Sampling Plan
ft/day	feet per day
gpd	gallons per day
GWDI	Groundwater Design Investigation
IRM	Interim Remedial Measures
K or k	hydraulic conductivity
lb/d	pounds per day
MDL	Method Detection Limit (Based on 40 CFR Part 136 Standards)
mg/l	milligrams per liter (parts per million)
MSL	Mean Sea Level
mu/cm	milliohms per centimeter
NPDES	National Pollutant Discharge Elimination System
NPDWS	National Primary Drinking Water Standards
NSDWS	National Secondary Drinking Water Standards
OEPA	Ohio Environmental Protection Agency
PCB	Polychlorinated Biphenyls
POTW	Publicly Owned Treatment Works
PQL	Practical Quantitation Limit (equivalent to CRDL)
PRP	Potentially Responsible Party
QC	Quality Control
RD SOW	Remedial Design Statement of Work
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record Of Decision
SOP	Standard Operating Procedure
SOW	Statement of Work
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids

DEFINITION OF TERMS AND ACRONYMS (Continued)

TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOX	Total Organic Halides
u	micron
ug/l	micrograms per liter (parts per billion)
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

In accordance with the requirements of the Administrative Order on Consent (AOC) between the United States Environmental Protection Agency and the Skinner Landfill PRP Group dated March 29, 1994, a Groundwater Design Investigation (GWDI) has been completed for design of the downgradient groundwater control system. This work was completed in accordance with the Statement of Work for Remedial Design, Skinner Landfill Site, Butler County, Ohio, and the Remedial Design Work Plan dated August 25, 1994.

The GWDI consists of two parts: 1) evaluating current groundwater quality around the Skinner Landfill and comparing these data to previous groundwater analytical results, and 2) collecting the necessary field data for design of the system to collect groundwater and, if necessary, design of a treatment train for the collected groundwater prior to discharge. Each part of the GWDI consists of several phases. The following is a summary of the findings and recommendations of the GWDI.

Groundwater Quality

Groundwater samples were collected from wells installed at the site during the Phase I and Phase II Remedial Investigations (RI) and the Interim Remedial Measures (IRM). These samples were analyzed and the results compared to previous analytical results. The comparison confirms that groundwater has been impacted at the site. The comparison also confirms that there is no clear pattern of contaminant distribution or plume migration. Groundwater conditions are the same as those used to develop the Record of Decision.

Modification of Trigger Levels

The Admistrative Order on Consent and attachments allow for modification of the trigger levels used to define groundwater contamination and thus require its collection. Methods for the evaluation and modification of the trigger levels were described in the Remedial Design Statement of Work (RD SOW). The RD SOW states that "In the case where the Table 1 (trigger) value is lower than the current Practical Quantitation Limit (PQL) attainable by CLP low-detection limit methods applicable to water, Contaminated Groundwater shall be defined as that which exceeds the PQL of the CLP low-detection limit water methods". For purposes of this document PQL and CRDL are considered to be equivalent. The applicable PQL (CRDL) can be found in *Quality Assurance Project Plan for Interim Groundwater Monitoring, Skinner Landfill Site, June 4, 1993.* Based on the results of the analytical data and evaluations, the following modifications of the trigger levels are made. For the inorganic parameters, six parameters remained at RD SOW trigger levels, eight were elevated to the Contract Required Detection Limits (CRDL), and two, iron and lead, were found to have statistically valid background concentrations present above both their RD SOW triggers and CRDL's. The modifed trigger levels for iron and lead were adjusted to the background levels. For volatile organics, all eighteen parameters remained at the RD SOW trigger levels. Of the semi-volatile organics, fifteen remained at the RD SOW trigger level, while eleven were adjusted to the CRDL.

Groundwater Collection

The proposed downgradient groundwater control system includes a combination of collection trenches and cut-off walls located south of the landfill and north of the East Fork of Mill Creek. Because of the geologic and hydrogeologic conditions encountered along the alignment, neither a cut-off wall nor a collection trench will be required for the full length along the southern limit of the landfill. The cut-off wall is required along portions of the alignment to minimize flow from East Fork of Mill Creek into the collection trench and to divert upgradient groundwater flow to the collection trench. Collection will only be required in areas where the overall hydraulic conductivity exceeds $5x10^{-5}$ cm/sec.

The collection system will consist of a trench with a perforated pipe at or near the base of the trench, granular backfill, and a geotextile to prevent clogging of the system. Collection trench bottoms will be sloped to a low point for the removal of the groundwater. The pipe will be installed to maintain gravity flow. Sumps with extraction wells will be located at the low points of the collection trench. Extraction wells will be used to pump the water to transmission pipes that will convey the water to the storage/treatment area. The groundwater transmission lines will be either force main or gravity lines. All transmission lines will be located on the landfill (north) side of the collection/cut-off trench.

Effluent Discharge Limits

The Work Plan specifies that proposed effluent standards be developed as part of the GWDI for discharge of the extracted groundwater to the East Fork of Mill Creek. Review of regulations indicate that Ohio Water Quality Standards will apply. Using criteria for classification of the receiving stream specified by the Ohio EPA and relevant regulatory authority (OAC Chapter 3745-10-7), criteria for water quality in the receiving stream was determined. Since the receiving stream has a low-flow 7Q10 of zero gallons per day, the groundwater will be required to meet the water quality standards upon discharge to the creek. However, comparison of the standards with the MDL's indicate that, for certain parameters, the water quality standard is below the MDL, making compliance impossible to demonstrate. Therefore, the effluent limits were proposed to be defined as the higher concentration between the applicable water quality standard and the MDL.

Groundwater Treatment

Groundwater samples were collected from the eight wells located along the proposed collection trench alignment. The analytical data from these samples were compared with the modified trigger levels. It was found that benzene, bis(2-chloroethyl)ether, and eight inorganic parameters exceeded their respective revised trigger levels. These data indicate that groundwater should be intercepted downgradient of the landfill. The hydraulic conductivity data from these wells was extrapolated along the entire length of the trench to develop an estimated total flow. The analytical data from the wells was associated with sections of the trench to arrive at the composite concentration. These data were then compared to the proposed effluent standards. The data indicate that the composited extracted groundwater meets the criteria of the proposed effluent standards for discharge to the East Fork of Mill Creek. As such, the wastewater nominally does not require treatment for trigger level compounds prior to discharge. However, solids removal will be required, and analysis will be conducted prior to discharge. Supplemental treatment options are proposed if future monitoring shows that treatment is required to meet effluent standards.

1.0 INTRODUCTION

1.1 General

This report presents the results of the Groundwater Design Investigation (GWDI) performed at the Skinner Landfill Superfund Site, West Chester, Butler County, Ohio. The GWDI was performed pursuant to the requirements of the Administrative Order on Consent (AOC) for Remedial Design for the Skinner Landfill Site between the United States Environmental Protection Agency (USEPA) and the Skinner Landfill PRP Group, dated March 29, 1994. The AOC and attachments present the selected remedial actions for the site and the requirements for design of the selected remedies. The GWDI was performed to provide the details for design of the interception and treatment of contaminated groundwater.

The groundwater design investigation consists of two parts. The first part defines the current groundwater quality around the Skinner Landfill and compares these data with the previous groundwater analytical results. The second part of the groundwater investigation includes collecting field data for design of the groundwater interception and treatment system. The GWDI was performed in general accordance with the approved Remedial Design Work Plan, dated August 25, 1994, and companion documents, Remedial Design Field Sampling Plan, Remedial Design Investigations Quality Assurance Project Plan, and Remedial Design Investigations Health and Safety Plan. Minor deviation from the Remedial Design Work Plan was necessary due to field constraints. The modifications are described in Sections 3.0, 5.0, and 6.1.

The remainder of this section of the GWDI presents descriptions and background information about the Skinner Landfill site. An overview of previous site investigations is presented in Section 2.0. Sections 3.0 and 4.0 of the report address the first part of the investigation, comparison of the current groundwater quality around the Skinner Landfill with the previous groundwater analytical results. Sections 5.0 and 6.0 address the second part of the GWDI, data collection for design of the interception system, and data collection for design of a treatment system. Each of these sections present findings of the investigations and recommendations for design of the system components. Section 7.0 provides a review of potential treatment processes, while Section 8.0 recommends the optimum treatment method and provides a basic process design scenario. The requirements for the Long Term Groundwater Monitoring Plan are presented in Section 9.0.

1.2 Site Location and Description

The Skinner Landfill Site is located approximately 15 miles north of Cincinnati, Ohio near the City of West Chester, Butler County, Ohio Township 3, Section 22, Range 2. The site is located along Cincinnati-Dayton Road as shown in Figure 1. The site is bordered on the south by the East Fork of Mill Creek, on the north by wooded, inactive land, on the east by Consolidated Railroad Corporation (Conrail) right-of-way, and on the west by Skinner Creek.

The site is located in a highly dissected area that slopes from a till-mantled bedrock upland to a broad, flat-bottomed valley that is occupied by the main branch of Mill Creek. Elevations on the site range from a high of nearly 800 feet above mean sea level (MSL) in the northeast to a low of 645 feet near the confluence of Skinner Creek and the East Fork of Mill Creek. Both Skinner Creek and the East Fork of Mill Creek are small, shallow streams. Both of these streams flow to the southwest from the site toward the main branch of Mill Creek. A third on-site stream, Dump Creek, borders the former landfill on the east; this creek is intermittent and flows south into the East Fork of Mill Creek. Three shallow ponds are also located on the site.

1.3 Site History and Background

The property was originally developed as a sand and gravel mining operation, and was subsequently used as a landfill from 1934 to 1990. According to EPA studies, materials deposited at the site include demolition debris, household refuse and a wide variety of chemical wastes. The waste disposal areas include a now-buried waste lagoon near the center of the site and a landfill. According to EPA studies, the buried lagoon was used for the disposal of paint wastes, ink wastes, creosote, pesticides, and other chemical wastes. The landfill area, located north and northeast of the buried lagoon, received predominantly demolition and landscaping debris.

In 1976, the Ohio EPA initiated an investigation of the site in response to reports of a black oily liquid that was observed during a fire call to the site. Before the OEPA could complete the investigation, the landfill owners, the Skinners, covered the lagoon with a layer of demolition debris. Mr. Skinner further dissuaded the OEPA from accessing the site by claiming that nerve gas, mustard gas and explosives were buried in the landfill. The OEPA requested the assistance of the U.S. Army after obtaining this information. Mr. Skinner later retracted his statements concerning buried ordnance, and a 1992 Army records review revealed no evidence of munitions disposal at the site.

In 1982 the site was placed on the National Priority List by the USEPA based on information obtained during a limited investigation of the site that indicated groundwater contamination had occurred as a result of the buried wastes. In 1986 a Phase I Remedial Investigation was conducted that included sampling of groundwater, surface water, and soil as well as a biological survey of the East Fork of Mill Creek and Skinner Creek. A Phase II Remedial Investigation was conducted from 1989 to 1991 and involved further investigation of groundwater, surface water, soils and sediments. A Feasibility Study was completed in 1992.

The field investigations have revealed that the most contaminated media at the site is the soil from the buried waste lagoon. Lower levels of contamination were also found in soils on other portions of the site and in the groundwater, and very low levels were found in the sediments of East Fork of Mill Creek, Skinner Creek, and the Duck and Diving Ponds. Migration of the contaminants has been limited, and the Phase II RI concluded that there had been no off-site migration of contaminants via groundwater.

In accordance with the December 9, 1992 AOC for Interim Remedial Measures (IRM), groundwater samples are being obtained and analyzed quarterly. In addition, a fence was installed around the Skinner Landfill site and is inspected on a continuing bi-weekly basis.

2.0 PREVIOUS FIELD INVESTIGATIONS

Groundwater data for the Skinner Landfill has been collected through several previous field studies. In addition, continuing data is provided through quarterly monitoring of wells at the site. These data form the foundation for the pre-design study and are recounted in the following sections.

2.1 Historical Data

Comprehensive Contract Laboratory Program (CLP) data for groundwater from various wells at the site can be found in the Phase I investigation performed by CDM Federal Programs Corp. (dated February 1989), and the Phase II investigation performed by WW Engineering and Science (dated May 1991). The following provides a brief overview of the findings of the RI, and the basis for the investigations performed during the GWDI.

In general, the site is underlain by relatively thin glacial drift over interbedded shales and limestones. The composition of the glacial drift ranges from intermixed silt, sand and gravel, to silty, sandy clays. Its thickness ranges from zero to 80 feet on the site. In a portion of the East Fork of Mill Creek area, bedrock is fully exposed in the stream bed. The hills and ridges are comprised of sand and gravel deposits which are encountered near the surface in the central portion of the site. The silts and clays usually occur as lenses in the sand and gravel or directly overlie bedrock. Clays occur at the surface in the far northeastern portion of the site and at the banks of the East Fork of Mill Creek and Skinner Creek.

Groundwater of interest to the remedial action at the site is contained in the glacial drift. Groundwater flow in the buried waste lagoon area is somewhat radial, toward the topographic valley west of the buried lagoon and the East Fork of Mill Creek. The clay tills which commonly overlie the bedrock combine with the limited vertical permeability in the bedrock to inhibit groundwater flow between the unconsolidated units and the bedrock.

The RI found sporadic and spatially variable evidence of groundwater contamination. The highest concentrations were found at GW20 and B5, which are immediately adjacent to and downgradient from the buried lagoon.

Quarterly groundwater monitoring has been performed at wells GW6, GW9, GW10, GW28, and GW38 since 1993. In general, low levels of volatile organics (primarily benzene) have been detected for the most part in well GW10. Bis(2-ethylhexyl)phthalate has been noted periodically in various wells, however, this may be a laboratory artifact. Of the metals, antimony, manganese, and iron are the most commonly found elements that exceed either the National Primary Drinking Water Standards (NPDWS) or the National Secondary Drinking Water Standards (NSDWS).

2.2 GWDI Work Plan Development

Based upon the RI data, USEPA selected a remedy that required intercepting the contaminated groundwater flowing from the buried lagoon and preventing its migration into the East Fork of Mill Creek via leachate seeps. The initial conceptual design for this was based on an interceptor trench in the unconsolidated sediments that would run essentially parallel to and alongside the creek. The trench would be used to collect groundwater migrating from the area of the buried waste lagoon toward the creek. The collected groundwater would be pumped to a storage tank, where it could be analyzed and treated (if required), prior to discharge to the creek.

To ascertain the technical viability of a trench collection system, a plan for investigation of the soil and groundwater characteristics along the proposed trench alignment was developed. The Remedial Design Work Plan document provides a description of field activities which includes completion of borings and characterization of unconsolidated sediments down to bedrock along the proposed trench alignment. The plan also outlines the installation of groundwater monitoring wells along the trench alignment, a sampling and analysis program for groundwater in these wells to determine the contaminant levels existing at the trench line, and chemical characterization of the water body that would receive effluent from the system.

Baseline concentration criteria of various parameters was established by the ROD and RD SOW. These criteria were designated as "trigger levels," and the parameters and associated concentrations are identified in Table 1 of the ROD. As part of this GWDI, the groundwater quality around the landfill will be defined and compared with the previous groundwater analytical results. The AOC and attachments allow for modification of Table 1 trigger levels by a statistical evaluation of background concentrations and laboratory detection limits. More information on this analysis and the resulting modification of the trigger levels is found in Section 4.0.

3.0 EXISTING MONITORING WELL EVALUATION - CONFIRMATION OF PREVIOUS GROUNDWATER ANALYTICAL RESULTS

To supplement the historical and quarterly data and to confirm that current groundwater conditions are essentially similar to those on which the ROD was based, a single, supplemental groundwater sampling and analysis program was instituted as part of the pre-design investigation. In total, twenty (20) existing wells were evaluated, and when possible, the groundwater sampled. In accordance with the Work Plan, the integrity, location, and labelling of each well was verified first. The depth of each well was then measured and compared to the depths indicated on the well logs to determine whether silting or well collapse had occurred, and whether redevelopment was required prior to sampling. A technical memorandum was submitted (See Appendix I) discussing the results of this investigation.

Sampling of the existing wells began on October 25 and ran through October 28, 1994. The samples were collected in accordance with the requirements of the Field Sampling Plan (FSP). The samples were analyzed for the full CLP Target Compound List/Target Analyte List (TCL/TAL) of parameters. Field data shows that of the 20 wells, 14 wells could be sampled (although not enough water was found in GW06 GW7R for the full CLP analysis). Of the six remaining wells, four (GW19, GW24, GW27, and B8) were dry. Well GW20 was inaccessible due to damage, and GW12 could not be located. A summary of analytical detections from the analysis of groundwater in these wells is provided in Tables 1 and 2, and the data are discussed below. Field observations and measurements are presented in Table 3. A complete listing of analytical results for the 14 wells is provided in Appendix II, and the laboratory reports are provided in Appendix VIII. For clarity, the tables show only those wells and parameters that were detected above the Contract Required Detection Limits (CRDL).

Although the approved Field Sampling Plan was generally adhered to in conducting the sampling, minor deviations were required in several cases due to physical or site-related restrictions. Wells

GW25, GW30 and GW31 were all hand-bailed due to vehicle access limitations which prevented use of the downhole pump. All wells were redeveloped prior to sampling to ensure no silting had occurred, per SOP-4, SOP-5, and SOP-6 (found in the Quality Assurance Project Plan for the Remedial Design).

3.1 Analytical Results

The analytical detections shown in Table 1 indicate that groundwater in well B5 contains a number of volatile organic compounds in excess of the RD SOW trigger levels. Among those so noted are vinyl chloride (46 ug/l vs. a trigger level of 2.0 ug/l), chloroform (120 ug/l vs. 79 ug/l), 1,2-dichloroethane (220 ug/l vs. 5 ug/l), 1,2-dichloropropane (580 ug/l vs 5 ug/l), and trichloroethene (52 ug/l vs 5 ug/l). Note that the CRDL for all these parameters is 10 ug/l. The data indicate well B5 also contained bis(2-chloroethyl)ether and bis(2-ethylhexyl) phthalate ~~slightly~~ in excess of the tentative trigger levels (41 ug/l vs. 13.6 ug/l and 50 ug/l vs. 49 ug/l, respectively).

In addition to the RD SOW trigger level apparent exceedances in well B5, 1,2-dichloropropane was detected in wells GW18 (22 ug/l), GW06 (22 ug/l), GW7R (15 ug/l), and GW 26 (16 ug/l) in excess of the RD SOW trigger level (5 ug/l). Benzene was found in well GW17 (100 ug/l vs. 10 ug/l). Bis(2-ethylhexyl)phthalate exceeded the trigger level (49 ug/l) in wells GW09 (75 ug/l), GW10(79 ug/l), and GW18 (140 ug/l).

No pesticides or PCB's were detected in any of the wells.

Inorganic constituent analyses were performed for both total (filtered through a 5 u filter) and dissolved (filtered through a 0.45 u filter) constituents (except for wells B5, which produced enough water for only a total metal analyses, and GW7R, which did not produce enough water for either total or dissolved analyses). Table 2 presents a summary of the inorganics found in concentrations greater than the applicable detection level. With a few exceptions, total and dissolved concentrations are essentially the same. Iron exhibited the greatest difference between total and dissolved concentrations, with at least an order of magnitude difference occurring in wells GW10, GW18, GW25, GW26, GW28, and GW31. Aluminum was detected in elevated total concentrations in wells GW09, GW10, GW25, GW28, and GW31, but was not detected in dissolved form. Significant differences in total and dissolved concentrations were also found in well GW31 for calcium and lead. Analytical anomalies occurred in wells GW18 (where arsenic was detected at 11.1 ug/l in dissolved form but was undetected in the total analysis) and GW38 (where the dissolved manganese was significantly greater than the total manganese). Based upon comparison with historical data, the dissolved fraction data for arsenic from Well GW18 and the dissolved fraction data for manganese from Well GW38 were discarded with respect to further data evaluation.

Evaluation of the inorganic analytical data reveals that arsenic, iron, lead, and cyanide were found at levels exceeding the RD SOW trigger concentrations. Arsenic was found at a concentration of 20 ug/l in Well GW17, versus a RD SOW trigger level of 5 ug/l. Iron exceeded the trigger level of 1.0 ug/l in every well, ranging from 203 ug/l to 12,000 ug/l. Lead was found in well GW10 at 5.4 ug/l vs. the RD SOW trigger level of 3.2 ug/l, and cyanide was found in GW10 at 10 ug/l vs. the RD SOW trigger of 5.2 ug/l.

In addition to "trigger level" compounds, inorganic compounds that could affect treatment and/or collection were analyzed. Of these, calcium, manganese, and magnesium are of the greatest interest because of the potential for scaling or fouling of piping and treatment units. Calcium concentrations ranged from 42,500 ug/l to 255,000 ug/l, with an average of 134,000 ug/l. Likewise, magnesium ranged from 18,700 ug/l to 91,200 ug/l, and manganese from 35 ug/l to 4,540 ug/l. As discussed in Section 8.0, these concentrations present the potential for corrosion of the collection and treatment system.

Field analytical data and general sampling notes are provided in Table 3. In general, all wells exhibited elevated turbidity, necessitating field filtering. While GW19 was dry, a black, ink-like substance was found on the water level probe when it was removed from the well. Also, during sampling of well GW31, steel cutting operations were being conducted at the landfill. Vapors from this cutting operation were observed at the wellhead, potentially impacting the atmospheric conditions of the sampling event. Of the field parameters, pH ranged between 6.67 at well GW17 to 8.05 at well GW26. Specific conductivity ranged from 0.824 mu/cm at well GW06 to 2.49 mu/cm at well GW11. Temperature of the groundwater ranged from 11.6° C. at well GW28 to 16.7°C at well GW11. No beta or gamma radiation was noted in any of the wells.

3.2 Comparison with Previous Data

Table 4 provides a comparison of organic data for samples collected at the 14 wells during the GWDI with historic data for these wells. Examination of the table shows there is no clear pattern or consistency. In nearly half of the wells, parameters that were detected historically were not detected during the GWDI, or vice versa. Wells GW06, GW09, GW10, GW11, GW12, GW19, GW24, GW26, and GW7R all fall into this category.

A few wells have shown some consistency, allowing consideration of possible trends. Well GW20 has shown consistency in the historical data, but was found to be damaged and inaccessible for sampling during GWDI.

Some consistency is notable for volatile organics detected at B5. Only 1,1,1-trichloroethane and xylene were detected in the Phase II but not in the GWDI. Of the consistently detected compounds, six decreased in concentration and five increased in concentration. Those parameters that decreased in concentration were 1,1-dichloroethane (52 ug/l to 45 ug/l), 1,2-dichloroethene (35 ug/l to 26 ug/l), benzene (21 ug/l to 10 ug/l), toluene (24 ug/l to 10 ug/l) trichloroethene (71 ug/l to 52 ug/l), and, vinyl chloride (48 ug/l to 46 ug/l). Those that increased in concentration were 1,1,2,2-tetrachloroethane (6 ug/l to 10 ug/l), 1,1,2-trichloroethane (55 ug/l to 130 ug/l), 1,2-dichloroethane (180 ug/l to 220 ug/l), 1,2-dichloropropane (370 ug/l to 580 ug/l), and chloroform (85 ug/l to 120 ug/l).

During the Phase II RI, the semi-volatile compounds 1,2-dichlorobenzene, 1,3- dichlorobenzene, bis(2-chloroethyl) ether, and napthalene were detected, albeit at relatively low concentrations in Well B-5. However, during the GWDI, only bis(2-chloroethyl) ether and bis(2-ethylhexyl) phthalate were detected. The only common parameter detected was bis(2-chloroethyl) ether. This compound decreased from the Phase II to the GWDI, going from 73 ug/l to 41 ug/l.

Wells GW17 and GW18 have shown somewhat consistent detections of benzene. In GW17, the benzene appears to have varied from 690 ug/l to 100 ug/l, while in well GW18, the concentration reduced from 950 ug/l to 890 ug/l to below the detection limit. It is unclear, however, whether this may be due to analytical variability or actual reduction in contamination. For instance, in well GW18, bis(2-ethylhexyl)phthalate was not detected in the Phase II, but was at the highest concentration found in any of the wells during the GWDI (140 ug/l).

Comparison of inorganic data between the GWDI sampling event and the previous investigations is provided in Table 5. Among all wells, antimony, cobalt, copper, chromium, mercury, vanadium, zinc, and lead (except for well GW10) were all detected in various wells during the historical investigations, but were not found in the 14 wells sampled during the GWDI. In several cases aluminum was detected in the GWDI, but not in the previous data, although the reverse was true in a few wells, notably GW17 and GW18. Also, a general pattern of data from the historical data to the GWDI is the increase in soluble sodium concentration. It may be postulated that this increase in sodium is due to attenuation of metals in the soil matrix, resulting in ion exchange and solvation of the sodium. For the most part, calcium, iron, and manganese increased from the Phase II to the GWDI. Well GW10 showed the most change with the three ions increasing markedly, in addition to the other changes noted earlier. Well GW11 showed similar characteristics at lower concentrations, as did wells GW28 and GW38. The exception was well GW18, where iron decreased significantly. Beryllium has never been detected in any of the wells, and selenium, silver, and thallium have been detected only very rarely.

In summary, the data from the 20 designated wells confirms that groundwater has been impacted at the site. However, there is no clear pattern of contaminant distribution or plume migration based on either the historic data or the GWDI data. Evaluation of the GWDI data shows that current groundwater conditions are essentially the same as those used to develop the ROD.

4.0 MODIFICATION OF TABLE 1 TRIGGER LEVELS

In accordance with the approved Work Plan, the data developed as part of this GWDI will be used to modify the trigger levels established in the RD SOW. The rationale for the modification is described in the SOW. "In some instances, the value listed in Table 1 is lower than that which is measurable by current standard methods". Compliance with Table 1 criteria would not be possible without adjustment to the minimum analytical quantification levels. Modification of the trigger levels will be performed in two steps: 1) for any compound listed in Table 1 of the RD SOW, if the Practical Quantitation Limits (PQL) is greater than the value listed in the table, the PQL will be substituted for the listed value; 2) for compounds that are determined to have definable background concentrations (as described in Section 4.1), if the background concentration is greater than both the listed value and the PQL, the background concentration will be substituted for either of these other values. Note that for purposes of this discussion, PQLs are the same as the Contract Required Detection Limits (CRDL) for the CLP SOWs used for this project (see QAPjP).

4.1 Graphical Evaluation of Data

The concentration of metals in groundwater at the Skinner Landfill was evaluated to define an appropriate background level for each metal. To define these levels, a graphical method was selected to evaluate existing groundwater data including those samples with non-detectable analyte levels. This method was proposed and approved in the RD Work Plan. A detailed discussion of the procedures used and the analytical and statistical variables is provided in Appendix III.

The selected graphical method is based on "pooling" previous groundwater data to define the background groundwater population. This method is very robust in that the selected background levels can be used to determine whether the data is normally or log-normally distributed.

The sample selection for this graphical evaluation was limited to those samples that were not field filtered or had only been pre-filtered to remove sand and silt size particles (i.e., using a 5.0 micron filter). These data were felt to be most representative of the water that would be collected in the trench. The resulting database (see Table 6) included the IRM data from April 1993 to July 1994 (wells GW06, GW7R, GW09, GW10, GW28, and GW29); the GWDI data from the existing groundwater monitoring wells (B5, GW09, GW10, GW11, GW17 GW18, GW25, GW26, GW28, GW30, GW31, and GW38); and the GWDI data from the monitoring wells installed along the proposed trench alignment (GW50, GW51, GW52, GW53, GW56, and GW57). All duplicate samples were included as a separate sample result. For the data reported as "non-detect", one-half of the detection limit was used per previous data analysis.

The use of the graphical method assumes that the variability in the data is due to both the normal variance in the background groundwater quality and the variance caused by the introduction of man-made contaminants. To separate the two populations, each metal was plotted in order of highest concentration to lowest concentrations. Next a straight line segment containing the lowest concentrations and the non-detect data (equal to one-half of the detection limit) were then extrapolated to a concentration in ug/l. This extrapolated concentration was defined as the background groundwater quality level for that metal.

The graphical method was only used on those metals where a RD SOW trigger had been set. In addition, no graphical analysis was conducted on those metals where the ratio of the number of detected analytes verses the number of non-detected analytes was less than 5% (see Table 7).

The graphs for the individual parameters are provided as Figures 3 through 13. The following briefly describes the results for each parameter of concern.

Arsenic — The graphical analysis indicates the background level of arsenic at the Skinner Landfill to be 4.3 ug/l (see Figure 3). This background level is based primarily on the large number of samples with non-detectable arsenic levels (i.e., 35 out of

46 samples).

Barium The graphical analysis indicates the background level of barium at the Skinner Landfill to be 235 ug/l (see Figure 4). This background level is based primarily on the non-detectable values reported for barium.

Cadmium The graphical analysis indicates the background level of cadmium at the Skinner Landfill to be 2.35 ug/l (see Figure 5). This background level is based primarily on the large number of samples with non-detectable cadmium levels (i.e., 41 out of 46 samples).

Chromium The graphical analysis indicates the background level of chromium at the Skinner Landfill to be 7.6 ug/l (see Figure 6).

Copper The graphical analysis indicates the background level of copper at the Skinner Landfill to be 13.0 ug/l (see Figure 7). This background level is based primarily on the large number of samples with non-detectable copper levels (i.e., 32 out of 46 samples).

Iron The graphical analysis indicates the background level of iron at the Skinner Landfill to be 5000 ug/l (see Figure 8).

Lead The graphical analysis indicates the background level of lead at the Skinner Landfill to be 4.2 ug/l (see Figure 9).

Nickel The graphical analysis indicates the background level of nickel at the Skinner Landfill to be 22.5 ug/l (see Figure 10). This background level is based primarily on the large number of samples with non-detectable nickel levels (i.e., 38 out of 46 samples).

Thallium The graphical analysis indicates the background level of thallium at the Skinner Landfill to be 4.2 ug/l (see Figure 11). This background level is based primarily on the large number of samples with non-detectable thallium levels (i.e., 43 out of 46 samples).

Zinc The graphical analysis indicates the background level of zinc at the Skinner Landfill to be 15.0 ug/l (see Figure 12). This background level is based primarily on the non-detectable zinc levels.

Cyanide The graphical analysis indicates the background level of cyanide at the Skinner Landfill to be 7.25 ug/l (see Figure 13). This background level is based primarily on the large number of samples with non-detectable cyanide levels (i.e., 42 out of 48 samples).

4.2 Development of Modified Trigger Levels

Table 8 provides the documentation for modifying the Table 1 RD SOW Trigger Levels in accordance with the methods described in the RD SOW and Work Plan. For clarification, the basis for the modified trigger level is highlighted. For the inorganic parameters, five remained at the RD SOW trigger levels, eight were elevated to the CRDL (PQL), and two, iron and lead, were found to be statistically present in the background above the RD SOW trigger and the CRDL levels. Note that the selenium trigger remained at 5 ug/l, which is also the CRDL. Of the eighteen volatile organic compounds, all 18 remained at the RD SOW trigger level. Finally, there were 26 semi-volatile parameters for which tentative trigger levels were established. Of these, 15 remained at this level, while 11 were adjusted to the CRDL. Per the Work Plan, no statistical evaluation was performed on the organic parameters.

4.3 Proposed Effluent Standards

According to the approved Work Plan, the GWDI must propose standards for discharge to the East Fork of Mill Creek, assuming the extracted groundwater is discharged to this receiving body. As such, the discharge would tentatively be regulated based upon National Pollutant Discharge Elimination System (NPDES) and equivalent state criteria. Review of applicable state and federal regulations indicate there are currently no categorical standards for discharge from CERCLA sites. Nor are there any known effluent standards specifically defined within CERCLA itself.

State of Ohio Water Quality Standards (OAC Chapter 3745-1-07) apply. Table 9 documents the apparent Ohio water quality standards that would be relevant to this stream. The numerical values presented in the table are based upon the 30 day average, warmwater, aquatic life habitat criteria, agricultural use water which is consistent with the OEPA designation found in *Biological and Water Quality Study of Mill Creek and Tributaries*, dated April 15, 1994. Note also that for determination of the inorganic standards, the value must be calculated based upon the hardness of the receiving waters. To make this determination, the calcium and magnesium data from the three surface water samples were averaged, then converted to hardness as calcium carbonate. It was assumed that all iron in the stream was in the ferric state and therefore did not contribute to water hardness. The hardness was calculated to be approximately 600 mg/l as calcium carbonate. However, according to Ohio EPA the value of 600 mg/l is outside the applicable range of this equation. A maximum hardness value of 500 mg/l was used. The resulting values are shown in Table 9, and are compared to the MDL's.

Water quality standards are designed to reflect the ambient quality of a stream. Therefore, mixing of the effluent from a point source (such as the discharge from the Skinner groundwater collection system) with the base flow of the stream is taken into consideration in developing the effluent standards for the point source. The seven day, ten year low flow (7Q10) of the stream is typically used as the baseline flow. In the instance of the East Fork of Mill Creek, the 7Q10 is 0.0 gpd. Therefore the mixing flow is zero, so theoretically the effluent from the groundwater collection system must meet water quality standards at the point of discharge to the creek.

Inspection of Table 9 indicates that the water quality standards are below the present MDL for silver, cyanide, 2-butanone, and bis(2-ethylhexyl) phthalate. Demonstration of achievement of the water quality standards is therefore not possible for these compounds. It is proposed that the effluent standards for discharge of groundwater from the Skinner site be established using a procedure similar to that used to establish the modified trigger levels. The effluent limit shall be the greater value of the MDL and the applicable water quality standard. Table 9 also documents these proposed standards by highlighting the applicable value. Further discussion of effluent limitations is provided is Section 6.3.

5.0 GROUNDWATER INTERCEPTION FINDINGS

The Administrative Order on Consent and attachments present the scope of pre-design field investigations needed to provide details for the design of the remedial action. An investigation of the geologic and hydrogeologic conditions between the buried lagoon and the East Fork of Mill Creek was required for design of the contaminated groundwater interception system. This section describes the investigation and its findings with respect to design of the interception system.

As a working concept, a continuous trench was anticipated for interception of groundwater. In the RD Work Plan, two possible routings were identified for the trench. To determine which alignment would be more technically feasible, a boring and sampling program was developed to characterize subsurface soil and groundwater conditions. This program consisted of twenty-one (21) borings drilled to bedrock. Figure 2 shows the location of the borings, designated B-59 to B-79. As noted, eight of the borings were converted to monitoring wells, designated GW-50 through GW-57. Logs for the borings are provided in Appendix IV.

The basic procedures for installation of borings and groundwater monitoring wells were defined in the Skinner Landfill Remedial Design Work Plan, Field Sampling Plan, and Quality Assurance Project Plan dated August 25, 1994. Per a technical memorandum dated November 8, 1994 (Appendix V), the exploration plan was modified to reduce the number of borings. Of the 21 borings planned, 17 were actually installed. Those not installed were B-68, B-71, B-72, and B-77 (locations not shown). Also, boring B-69 (new location shown) was moved downslope due to access constraints.

The following sections present the results of the GWDI with respect to geology (Section 5.1), hydrogeology (Section 5.2), and design of the groundwater collection system (Section 5.3).

5.1 Geology

Seventeen borings were drilled along the proposed groundwater interceptor trench alignments and monitoring wells were completed in eight of the borings. This information, together with data from the RI, have been used to further define geologic and groundwater conditions along the groundwater interceptor trench alignment. Contours of the surface of bedrock are shown on Figure 14. Cross sections perpendicular to the East Fork of Mill Creek and generally parallel to the creek are shown on Figures 15 and 16. The potentiometric surface for the groundwater flow between the buried lagoon/landfill and the East Fork of Mill Creek is shown on Figure 17.

According to the RI, the bedrock surface beneath the site slopes generally to the south toward East Fork of Mill Creek, mimicking the surface topography. Thus, a bedrock "knob" was indicated projecting south in the area immediately south of the buried lagoon. The RI data also indicated a roughly triangular bedrock low in the area near wells GW-06, GW-07R and GW-38 (see RI Phase II, Figure 3.12).

Borings drilled during the GWDI on the topographic knob south of the buried lagoon (B-51 and B-70) did not encounter a bedrock "knob" as anticipated. The surface of bedrock in this area slopes gently to the south, consistent with trends of the bedrock surface to the north and east of the knob. In additional, the bedrock low identified in the RI was found to be elongated toward the east-northeast, giving it the form of a buried valley.

The GWDI borings show that the lower portion of the buried valley is filled with glacial till. The till is overlain by sand and gravel, which is overlain in turn by other fine-grained soils and some fill materials. The sand and gravel layer appears to be somewhat continuous both northward away from the creek and in an east-west direction along the creek. These features are shown in the geologic sections depicted on Figures 15 and 16. Section A-A' (Figure 15) generally parallels East Fork of Mill Creek. Sections B-B' (Figure 15), C-C', D-D', and E-E' (Figure 16) were constructed generally perpendicular to East Fork of Mill Creek.

As shown on Section A-A', the surface of bedrock along the interceptor trench alignment slopes to the west from the east site boundary. East of boring GW-55 the elevation of the bedrock surface is at or above the elevation of the East Fork of Mill Creek. West of boring GW-55 and east of boring B-78, the bedrock surface is below the creek. The buried bedrock valley is present west of B-78.

Glacial till overlies the bedrock surface and appears to be continuous across the study area as indicated on the sections. The till is an unsorted, unstratified heterogeneous mixture of sand, silt and clay deposited directly beneath the glacier without subsequent reworking by glacial melt waters. Till deposition was controlled/modified by the shallow bedrock surface which resulted in greater thickness of till being deposited in the buried valley. The valley filling is evidenced by borings GW-50, B-76, GW-52, GW-53, B-79, GW-54 and B-73. Within the till, stringers of sand exist as shown on the sections (e.g. GW-52). It appears that the sand lenses are limited and are not laterally extensive.

Above the glacial till are sands and gravels deposited by glacial melt waters during an interglacial period. Along the proposed trench alignment (Section A-A'), the sand/sand and gravel deposits are generally absent east of GW-55. West of GW-55, the sand appears more continuous. Borings GW-51 and B-70 drilled on the knob south of the buried lagoon indicate that the granular deposits are quite thick. Within the granular deposits, occasional layers of silt and clay exist (Boring B-70). These layers reflect changes in glacial meltwater flow characteristics at the time they were deposited.

The sands and gravels are typically overlain by finer-grained sediments. The fine-grained deposits encountered above the sand in borings drilled along East Fork of Mill Creek may be of fluvial origin, having been deposited by flows in the more modern East Fork of Mill Creek. In other areas of the site and particularly on upland areas, these fine-grained deposits may be a combination of till deposited during a subsequent glacial advance and sediments deposited by slope-forming processes during deglaciation.

Many of the borings encountered fill material at the surface as a result of past land usage. The thickness of the fill varies from about 3 feet to a maximum of 10 feet at boring B-76. The fill is not continuous along the trench alignment.

5.2 Site Hydrogeology

The unconsolidated deposits described in the previous section and shown on the cross sections are the primary pathway for groundwater migration from the lagoon/landfill area to East Fork of Mill Creek. In general, groundwater migrates more easily through the more permeable sands and gravels, and is impeded by the less permeable deposits of clay and silt. As shown in the cross sections, sand and gravel deposits at the site occur as laterally continuous and discontinuous zones and in isolated pockets. Recharge to these zones is primarily via rain water infiltration in the upland areas of the site. Groundwater flows toward and discharges to the East Fork of Mill Creek.

Groundwater levels were measured in wells installed for the GWDI and in selected RI wells. Table 10 is a tabulation of groundwater elevations computed from those measurements and historical groundwater elevations in RI wells. Figure 17 shows the potentiometric surface for groundwater in the unconsolidated sediments near the proposed collection trench as determined during the GWDI, which is consistent with the findings of the Phase I and Phase II RI. The elevation of the groundwater, the direction of groundwater flow, and the magnitude of the gradients are essentially the same among the three investigations, indicating a stable groundwater flow regime.

Bail-down recovery tests were performed in wells constructed along the proposed groundwater interception system alignment to estimate the hydraulic conductivity (K) of the soils surrounding the well screen. The GWDI wells were screened through the entire saturated zone to intercept all water that will flow to the interceptor trench. Appendix VI contains a discussion of the tests and the calculations of hydraulic conductivity. The table below summarizes the test results.

Well	Hydraulic Conductivity	
	gallons/day/ft^2	cm/sec
GW50	0.31	1.5×10^{-5}
GW51	0.54	2.5×10^{-5}
GW52	0.0025	1.2×10^{-7}
GW53	1.19	5.6×10^{-5}
GW54	0.08	3.8×10^{-6}
GW55	0.001	4.7×10^{-8}
GW56	3.43	1.6×10^{-4}
GW57	1.19	5.6×10^{-5}

All measured values of hydraulic conductivity fall between 0.001 and 10 gallons/day/ft^2. These values are typical for silts and glacial tills, which are the predominant soil types encountered along the proposed trench alignment. The geometric mean of the hydraulic conductivities is 6.7×10^{-6} cm/sec.

5.3 Groundwater Interception

The Remedial Design Work Plan indicated that there are generally two options for the interception of groundwater flowing from the buried lagoon/landfill area to the East Fork of Mill Creek. The two options identified include an interception trench and individual groundwater extraction wells. The following section briefly discusses the results of the Groundwater Design Investigation with respect to these options, and identifies the recommended method for groundwater collection.

5.3.1 General Technology Considerations

Interceptor trenches have proven very effective in collecting ground water even where significant variation in soil materials are present. To successfully intercept the flow, it is not required to have a low permeability "curtain" behind the interceptor trench. It is critical that the trench material have a higher permeability than the layers feeding it. Interceptor trenches are an applicable method for intercepting and collecting groundwater at the site.

Groundwater extraction wells are very effective when the stratigraphy is relatively uniform and has a high permeability. A consistent stratigraphy is required to accurately predict the zone of influence of each well, thus dictating the well spacing. In the case of random stratigraphy, the well zone of influence is more difficult to predict and significant factors of safety are required to provide some assurance that the system will be effective. However, small, isolated sand seams between wells may still render the line of wells ineffective. Isolated wells are not appropriate for the stratigraphy at the site and will not be considered.

5.3.2 Trench Technology Considerations

An interception trench may be either a cut-off wall, a collection trench or a combination of the two. Selection of the best method is dependent upon several key items: the continuity of the stratigraphy, the permeability of the materials present, and the configuration and depth of the low permeability surface below the area of concern.

At the Skinner site, the stratigraphy is relatively random with sand/sand and gravel layers interspersed within the silt/clay layers. Some of these granular layers appear to be relatively continuous for portions of the site. Other high permeable layers are moderate in thickness and extent. Depth to bedrock varies considerably along the proposed trench alignment, reaching depths of 35 feet near its western end. These conditions suggest that a combination of cut-off walls and collection trenches will be applicable to the site.

5.3.3 Groundwater Cut-off Options

Cut-off walls can be constructed using a variety of methods that have varying effectiveness and costs. The different options include slurry walls, grout curtains, diaphragm walls, vibrating beam cut-off wall, and geomembrane barriers.

Slurry walls are generally excavated through a clay-water slurry that provides support for the trench walls. The trench is then backfilled with additional low permeable material. Typical materials are soil-bentonite or cement-bentonite mixtures. These walls have been highly effective in cut-off characteristics and can provide permeabilities as low as 1×10^{-7} cm/sec. Slurry trench cut-off walls are an applicable cut-off method for this site.

Grout curtains are constructed by either permeation grouting or jet grouting. Permeation grouting is defined as the filling of the pores of the soil with low permeability material. This method is difficult to implement even in the best of conditions. With the materials present in the Skinner soil profile, the method is not applicable.

Jet grouting uses high pressure jets to mix cement with the disturbed soil and has proven to be highly effective. To jet grout an area, a series of vertical holes are drilled in sequence and the area between holes is injected with the cement to form a low permeability wall. The spacing between holes and the amount of cement used is dependent on the knowledge of, and consistency of, the stratigraphy. Again, the random stratigraphy at the site would decrease the effectiveness of jet grouting. Jet grouting is not recommended for the site.

Diaphragm walls are constructed using the same methods as used for slurry walls. However, in lieu of nonstructural, low permeability material as backfill, concrete is tremied into the slurry mixture with some form of reinforcement. This allows the wall to function as a ground support. Diaphragms walls are moie costly than slurry walls, and provide minimal additional reduction in permeability as compared to the slurry walls.

Vibrating beam cut-off walls are also quite effective as vertical groundwater barriers, especially when there are a tight construction constraints. As the vibrating beam is "moved along" the defined path (repeatedly inserted into the ground), the small void left behind by the beam is filled with a slurry as the beam is withdrawn. The result is an effective, low permeable cut-off wall without trench construction. Vibrating beam "excavation" cannot consistently excavate into bedrock. This inability renders the method unacceptable for this project.

Geomembrane barriers [e.g., High Density Polyethylene (HDPE)] can be constructed using a slurry trench type of construction. In areas where groundwater removal and groundwater flow cut-off are required, a geomembrane can be installed as part of the removal trench or in a separate cut-off wall. Geomembrane barriers have proven effective in sites with varying soil conditions. This is a viable method for groundwater cut-off at the Skinner site.

5.3.4 Recommendations

Figure 18 shows the interceptor trench alignment recommended on the basis of the GWDI. The trench is positioned as far as possible from the creek to minimize the impact of construction on the slopes adjacent to the creek and to allow for proper erosion control measures during construction to protect the creek. In addition, the trench is located at least twenty (20) feet from the edge of the slope adjacent to the creek to allow for vehicular traffic during the operation and maintenance period. The eastern terminal point of the trench is approximately twenty (20) feet from the east property line of the site to allow for construction activity to take place. At the west end, the trench will terminate near boring B-67. Interpretation of the potentiometric surface along the alignment (Figure 17) indicates that groundwater flow from the buried lagoon will not bypass boring B-67.

Two potential trench alignments had been identified in the RD Work Plan. The first option generally followed the alignment of East Fork of Mill Creek. The second option varied from the first alignment in the area just south of the buried lagoon. This second alignment has been eliminated because the depth to bedrock would significantly complicate construction. Section C-C' on Figure 16 indicates a depth of approximately 60 feet from existing ground surface elevation to top of bedrock. This depth exceeds the limit of normal trench capabilities.

The recommended groundwater interception system is comprised of two different elements, an interceptor trench and a cut-off wall, that are proposed singly or in combination based on existing subsurface conditions. The hydraulic conductivity of the strata is a determining criterion for trench type. In areas of higher hydraulic conductivity, an interceptor trench is recommended. The purpose of the trench is to intercept (collect) groundwater flow and transmit the flow to groundwater extraction points. For segments of the trench where the hydraulic conductivity is low, an interceptor trench is not recommended. Interceptor trenches will extend to bedrock in the absence of cut-off walls.

The cut-off walls have several functions. In areas where no collection trench is recommended, the cut-off walls will divert groundwater flow to adjacent areas having more permeable soils. In areas where cut-off walls and interceptor trenches are both recommended, the cut-off walls will a) eliminate the potential to draw water from the creek into the trench where the bedrock is lower than the creek, and b) allow the interceptor trench to be positioned four to five feet below the creek surface instead of at the top of rock. At this shallower depth, the interceptor trench will be easier and less costly to install. This configuration will also minimize the differential head on the cut-off walls, improving its effectiveness and long-term reliability. In all cases, cut-off walls, whether in combination with an interceptor trench or as a stand-alone measure, will extend to and be embedded at least 3 ft into the bedrock.

The following paragraphs present recommendations for the use of the three trench systems (an interceptor trench, an interceptor trench in conjunction with a cut-off wall, and a cut-off wall) along the proposed alignment beginning at the east end of the system. Where the combination of two types of systems are recommended, it is not intended that the wall and trench be restricted to separate trenches or a single trench. This decision will be made during the design phase. The proposed alignment is shown in plan view on Figure 18. The limits of each trench type and proposed flow line elevation of the interceptor trench is shown on Section A-A', Figure 15.

<u>East End to GW-55</u> An interception trench is recommended from the east end of the trench to the approximate location of GW-55. In this section, the water surface elevation in the creek is below the level of bedrock along the trench. As a result, it is anticipated that groundwater collection along the trench will not draw water from the creek. This length of trench is in an area of "high" hydraulic conductivity.

<u>GW-55 to B-73</u> A cut-off wall is recommended from GW55 to B-73. In this section the bedrock level along the trench is below the surface water of the creek. In order to prevent draw down of the stream, a cut-off wall is proposed. Since the hydraulic conductivity is low in this area, and the

bedrock generally slopes to the west, no collection is proposed.

B-73 to B-79 An interception trench and cut-off wall are recommended from B-73 to B-79. The creek surface water elevation is above the bedrock elevation along the trench and there is a low point in the bedrock in the vicinity of B-79. The borings also indicate a dip in the sand seam near B-73. The hydraulic conductivity in this area is relatively low, but the groundwater flow lines are convergent. For these reasons, a combination cut-off wall interceptor trench is recommended for this section of the alignment.

B-79 to GW-52 A cut-off wall is recommended from B-79 to GW-52. In this section the bedrock slopes from a high point near boring B-78 toward both ends of the section. The water surface in the creek is above the bedrock level along the alignment except for a short segment near boring B-78. The hydraulic conductivity along this portion of the trench is moderate, and the flow lines are divergent. For these reasons, only a cut-off wall is recommended for this section of the alignment.

GW-52 to B-67 An interceptor trench and a cut off wall are recommended from GW-52 to the western end of the collection system near boring B-67. In this section, there is low to moderate hydraulic conductivity and the bedrock is below the creek surface water elevation. As indicated on Section A-A', Figure 15, the interceptor trench will extend into glacial till approximately four feet below the surface water elevation of the creek and slope to the west end of the section. The cut-off wall will extend to bedrock. The interception/cut-off trench system will terminate near boring B-67.

For all interceptor trenches, it is proposed that an extraction "well/sump" be installed at the low point on the trench. At this point, it is anticipated that the cut-off wall will be either an HDPE barrier, a slurry wall or a diaphragm wall. A diaphragm wall will only be used if it can be designed to serve as a cut-off wall and stream bank protection in the area of GW54. The construction of the interceptor trench is proposed to include a perforated pipe, granular drainage material and a geotextile wrap. The material specifications as well as pump and force main criteria will be developed in the design phase of the project.

5.3.5 Design Analysis

The estimate for the composite flow from the interceptor trench was developed utilizing the calculated hydraulic conductivities described above and dividing the trench into 100 foot long segments. The flow rate per 100 foot length of trench was derived from a method described by Powers(1) (see Appendix VII and Table 11). It is assumed that the construction of the GWDI wells along the proposed alignment represent the trench condition in terms of interception of the full saturated zone. Each well was assumed to describe the overall hydraulic conductivity of a specific trench condition and section.

The trench was evaluated in the 100 foot segments using the stratigraphy along the alignment (Section A-A', Figure 15) to select a corresponding hydraulic conductivity (K), measured thicknesses of influence (H and h), and a length of influence (L). For instance, GW-54 has a very low hydraulic conductivity and the groundwater level is at the bottom of the sand seam, but the geologic cross section shows that the sand seam on either side of this area is saturated. In this case the trench will receive a higher flow than what was projected at the well. Therefore, it is assumed the hydraulic conductivity for this area will actually be higher, similar to the condition at adjacent well GW-53.

The influence length (L) was assumed to vary over time as the system operated. Over time the trench should attain a steady state condition with the collected flow being similar to surface water recharge in its "drainage area". A generalized estimate of the surface water recharge is approximately 1,750 to 2,000 gallons per day (gpd) based on a trench length of 1400 ft, an upgradient recharge distance of 400 ft measured perpendicular to the trench, and an infiltration rate of 2 inches per year for sites with moderately steep slopes and silty soils.

Table 11 shows the effect of changes in the influence length (L) that will result with continued groundwater removal from the interceptor trench. The 100 foot segments were identified with the individual wells on the proposed trench alignment, so that each well was deemed to represent a specific section of the trench. The 100 foot sections were then added to arrive at a total flow for the reach the well represented. Table 11 documents, for each iteration, the flow in gallons per day from each reach and the total estimated flow from the trench. Initial collection volumes are anticipated to be approximately 11,000 gpd. This high initial collection volume assumes that the trench is fully dewatered at start-up. By controlling pumping and drawdown within the trench, a more manageable initial flow rate may be achieved. Over time, with continued groundwater removal, total collected volumes are expected to decrease until an equilibrium is reached with local recharge.

6.0 GROUNDWATER TREATMENT FINDINGS

In conjunction with the physical characteristics of the soil and bedrock along the trench area, eight (8) of the borings along the trench line have been converted into groundwater monitoring wells for collection of groundwater samples. Analysis of the chemical characteristics of the groundwater in this area will provide data for design of the treatment units operation(s) required to achieve effluent standards. In accordance with the approved Work Plan for the Site, each groundwater and surface water sample location was analyzed for the full CLP TCL/TAL, plus the design parameters (BOD, COD, TDS, TKN, TOC, TOX, sulfides, iron, calcium, magnesium).

6.1 Results of Investigation - Chemical Data

During sampling and analysis, the Field Sampling Plan requirements could not be fully complied with in a few instances. Initial analysis for BOD was not performed because laboratory holding times were exceeded. Therefore, all wells had to be resampled (using hand bailers) for BOD only. None of the samples were field filtered in accordance with the SOPs found in the FSP (but in contrast to procedures used for the 20 existing wells and IRM wells). The reasoning for this change is that unfiltered samples will more accurately reflect the water collected by the trench.

As documented in Appendix IX, QC validation of the data indicated that, while some of the data was estimated, estimated data are considered valid and usable. No data qualified as unusable, therefore the usability of the data package is 100%.

6.1.1 Trench Line Wells

A summary of analytical detections is provided in Table 12, which shows the detected organic constituents, and Table 13, which provides inorganic data. Full laboratory data to support data shown on these tables are in Appendix IX. Note that for clarity these data tables have been reduced by eliminating wells where no parameters were detected above the CRDL, and eliminating parameters that were not detected in any of the wells. Individual blank cells within the tables indicate the corresponding compound was not detected in that particular well.

In Table 12, well GW51 exhibited bis (2-chloroethyl) ether in excess of the modified trigger level (41 ug/l vs 13.6 ug/l) and benzene in excess of the modified trigger level (220 ug/l vs. 5 ug/l). In well GW53, bis (2-chloroethyl) ether was in excess of the modified trigger level (40 ug/l vs 13.6 ug/l), as was benzene (20 ug/l vs. 5 ug/l).

Table 13 shows the detected inorganic parameters. Several parameters were detected in all wells. These included aluminum (ranging from 967 ug/l to 26,200 ug/l), calcium (ranging from 388,000 ug/l to 659,000 ug/l), iron (ranging from 29.7 ug/l to 62,900 ug/l), lead (6.6 ug/l to 45.9 ug/l), magnesium (103,000 ug/l to 143,000 ug/l), manganese (899 ug/l to 3390 ug/l), potassium (10,200 ug/l to 29,500 ug/l), and sodium (35,300 ug/l to 142,000 ug/l).

Arsenic was detected above the modified trigger level (10 ug/l) in GW51(18.1 ug/l), and GW52 (16.8 ug/l). Barium was detected above the modified trigger level (1000 ug/l) in GW50 (1060 ug/l). Chromium was detected above the modified trigger level (11 ug/l) in GW50 (33.6 ug/l), GW52 (46.5 ug/l), GW53 (13.4 ug/l), GW56 (18.4 ug/l), and GW57 (26.4 ug/l). Copper was detected above the modified trigger level (25 ug/l) in GW50 (53 ug/l), GW52 (68.8 ug/l), and GW57 (25.1 ug/l). Silver was detected above the modified trigger level (10 ug/l) in GW53 (29.1 ug/l). Zinc was detected above the modified the trigger level (86 ug/l) in GW 50 (155 ug/l) and GW 52 (212 ug/l).

6.1.2 Surface Water Samples

Table 14 presents the results of surface water samples taken in the East Fork of Mill Creek, October 10, 1994. Sample locations are shown on Figure 2. The laboratory reports and validation are found in Appendix X. As can be seen, the only two organic parameters detected were methylene chloride and acetone, which are both likely laboratory artifacts. No organic compounds were detected above the modified trigger levels. Aluminum, calcium, magnesium, manganese, potassium, and sodium were all detected in most sampling points, but there are no trigger levels established for these parameters. Barium was detected, but below the trigger level and the CRDL. Finally, cyanide was detected at 57.6 ug/l in SW51, above the trigger level of 10 ug/l. SW-51 is located at the southwest corner of the site near GW7R.

6.1.3 Design Parameters

Table 16 presents a summary of analytical data (laboratory reports contained in Appendix X) for the trench wells for parameters designated as the design parameters. Review of the data indicates the groundwater is very low in organic content, but relatively high in Total Dissolved Solids (TDS). Note also that except for well GW53, Total Organic Halides (TOX) were below detection limit. Field data from the wells is provided in Table 15.

6.2 Estimate of Composite Extracted Concentration

Tables 17 and 18 provide, respectively, calculation of the estimated composite concentration of organic and inorganic contaminants derived from the trench system. The methodology used to determine the composite concentration is as follows. As discussed in Section 5.3.4, each monitoring well along the proposed trench was used to define a specific reach of the trench for which a total flow in units of gallons per day was estimated. Each well also provided analytical data for the contaminants of concern. The concentration (in ug/l) of each contaminant was then multiplied by the daily flow rate and the units adjusted to arrive at the mass (in pounds per day) of contaminant from that specific reach of the trench. The sum of the masses from the individual reaches was then divided by the total flow to determine the composite concentration for each parameter. As demonstrated in Section 5.3.4, the flows are expected to vary over time, as the aquifer is drawn down and recharge is limited to precipitation. The maximum flow is expected at the start of the project. For the purposes of this evaluation, this maximum flow (approximately 11,000 gpd) has been used to calculate the composite concentration of contaminants as well as hydraulic design of the system. It is felt this value will represent the "worst case" conditions of volumetric and contaminant loading from the trench.

6.3 Comparison with Revised Trigger Levels and Proposed Effluent Standards

Tables 17 and 18 show that, based upon the estimated flows from the trench, no inorganic or organic compounds will exceed the proposed effluent standards. However, several parameters are within one order of magnitude of the limit. This would suggest that, given normal statistical variability, the extracted groundwater may have a slight potential to exceed the proposed effluent limits. This can only be determined upon completion of the trench installation and commencement of groundwater extraction.

7.0 TREATMENT OPTIONS

While the tentative indication is that no treatment of the groundwater is required prior to discharge to the creek, the data base for this determination is small. Therefore, a brief discussion of treatment processes that could be applied to the parameters detected at the site has been developed, in case treatment is required in the future. The discussion provides a conceptual overview of the process, and strengths and weaknesses of each method as it relates to different classes of contaminants. A general evaluation of the method as it relates to the wastestream at the Skinner Landfill follows. An evaluation of the first option, no treatment, is not only expected but is required in all CERCLA response actions.

In reviewing the treatment options, several factors were considered. The treatment system should be designed so that capital and operating costs are minimized while still meeting the performance requirements. Space for installation of a treatment system is limited, therefore single unit operations which accomplish a number of performance requirements with minimum footprint are preferred. Given the somewhat remote location, the ease of operability such that the labor requirement is minimized, or ease of automation so that the system will function without operator attention, is of importance. The proximity to homes and schools indicate the need for control of air emissions, noise, and odors. Minimization of residuals that require additional treatment is advantageous from both an environmental and cost standpoint. Finally, the system must demonstrate the ability to reliably and consistently meet effluent standards while minimizing potential for process upsets.

7.1 No Treatment

The no treatment option would consist of simply pumping the groundwater collected in the trench system directly into the East Fork of Mill Creek. Analysis would be performed prior to discharge, at least early in the operation. This option is considered viable because historical data and trench-line composite water quality calculations demonstrate the concentration of contaminants found in the groundwater to be lower than the proposed effluent discharge standards.

7.2 Collection, Treatment Off-Site

In this option, groundwater exceeding the limits would be collected in tankage and periodically trucked or pumped via force main to an off-site treatment facility. Trucking would not be considered feasible if a large volume of water would require treatment.

Installation of a force main to a nearby municipal or industrial treatment facility has been investigated. Municipal wastewater treatment plants in Butler County that are within reasonable proximity to the site are West Chester and Mason. However, these are relatively small communities, so it is possible that even a relatively small flow from the Skinner site would hydraulically overload the POTWs. On the other hand, the site is within approximately 3 miles of the Hamilton County border where access to the City of Cincinnati sewers is available, and several major industries are within a five mile radius of the site. These other entities may be willing to accept collected groundwater for treatment and discharge through their facility. At this time, initial contact with the municipalities or industries has not been made.

7.3 Collection, Treatment On-Site

In this option, the collected groundwater which exceeds the limits would be treated on-site and discharged to the creek. Based upon review of the historical and GWDI data, treatment might be required for solids, metals, or organics. Depending on treatment equipment needed, additional treatment to reduce scaling and other maintenance problems may also be prudent. On-site treatment could fall into three categories: physical, chemical, and biological.

7.3.1 Physical Treatment

Physical treatment processes may consist of gravity sedimentation (clarification), centrifugation, flotation, filtration, adsorption, and air stripping. Sedimentation processes usually are supplemented by chemical addition for destabilization, and polymer addition for coagulation and flocculation. A key element in effective sedimentation is reduction in the velocity of the water, or quiescent conditions, to allow the heavy solids to settle. Typically, this is accomplished in a large diameter or long rectangular tank, with continuous or periodic removal of the solids from the bottom. A corollary process is centrifugation, in which the wastewater is placed in a centrifuge to induce higher gravities and correspondingly higher separation.

In review of the data from Skinner, it appears some form of clarification to remove turbidity prior to further treatment could be required. However, the groundwater appears to contain a significant amount of colloidal solids that would not readily settle without chemical addition. This would likely result in generation of a relatively thin sludge that would require dewatering prior to disposal. Also, clarifiers are typically open-air units, which may be a concern if odors are present. For these reasons, gravity clarification, while technically appropriate, may not be a preferred process operation. Centrifugation, while it is a closed process, is generally applied to wastestreams with higher suspended solids content. The technology is therefore considered to be less desireable than other alternatives.

Flotation is essentially induced gravity sedimentation in reverse. It is generally applied to wastestreams high in oil or other lighter phase components. At Skinner, there have been no free floating product phases noted. As such, flotation is not considered to be required in this application.

Filtration consists of physical retention of solids on a porous media as the aqueous phase passes through the media. Filtration can be further broken down based upon the extent to which solids removal is required. Gross separation of insoluble materials can be accomplished by slow or rapid sand filtration, precoated filter media, disposable cartridge filters, and similar methods. As removal of smaller, more soluble particles is required, microfiltration, ultrafiltration, and reverse osmosis become options.

Slow or rapid sand filtration has been demonstrated to be effective in a number of applications. The units can be enclosed, minimizing vapor emission. Wastewater can be introduced in either a downflow or upflow configuration. The solids are retained initially on the top surface layer of the sand. As filtration continues, the removed solids work their way into the sand media, achieving depth filtration, but eventually fouling the sand to the point where flow is inhibited. At this point, the filter must be cleaned. Typically, a reverse flow of water (backwash) is introduced into the filter to wash out the accumulated solids. Once the solids have been removed from the media, operation can resume. However, because the media remains in the filter, it may be susceptible to long-term fouling.

An alternative is the use of renewable filtration media on a fixed surface. This type of operation is called precoat filtration, whereby a slurry of dense but porous material (such as diatomaceous earth) is pumped into a unit containing a fixed porous media with a large surface area. The precoat forms a thin layer on the media, which then becomes the filtering agent similar to the surface of a sand filter. Precoat filtration operations have been used in applications where it is desirable to periodically remove the contaminated media. Also, replaceable media allows easier change of the media size, which allows adjustment of the filtration effectiveness. Finally, the replaceable media systems will typically produce a higher solids content residual than the backwash stream from a sand filter, reducing residuals management costs. In summary, it is felt that sand filters and precoat filters are viable options for application at the Skinner Landfill site. Based upon previous experience and review of the conjectured wastestream characteristics, it appears at this time that precoat filtration may be preferable to sand filtration. Both these systems are nominally batch operations, and have been successfully automated.

Adsorption in wastewater treatment is the process of removal of specified compounds through phase change and attachment to a fixed media. Two of the more common adsorption processes are ion exchange (generally for inorganic compounds) and carbon adsorption (generally for organic compounds).

Adsorption of inorganic materials by ion exchange can be accomplished via several mechanisms. "Standard" ion exchange resins will remove essentially all multivalent ions. Based upon review of the inorganic data from the Skinner Landfill, this is desirable, in that the concentration of cationic species such as calcium and magnesium (the primary elements of water hardness) as well as iron are such that significant scaling of operating units would occur if they were not removed from the water stream. Cursory review of Langlier Saturation Indices and Caldwell-Lawrence diagrams with respect to the precipitation potential indicate the groundwater is highly oversaturated with hardness. This means that corrosion is likely to occur if the calcium and magnesium are not removed. Conventional lime-soda softening is a viable process option, but due to potential for air emissions, volume of sludge generated, and anticipated costs, ion exchange is likely a preferred operation.

As with filtering, continual adsorption of the contaminants from the wastesteam eventually results in fouling of the resin. The columns must be periodically regenerated, typically with a strong acid (for cations) or a strong base (for anions), then returned to service. The regeneration waste must be treated and disposed.

A review of those organic constituents detected in the historical wells and the trench line wells indicates that all, to a varying degree, are adsorbable onto activated carbon. Activated carbon will eventually become spent, necessitating replacement or regeneration. At this time use of activited carbon is not anticipated, but is an acceptable option if organic treatment is required.

Air stripping is a process frequently used in groundwater treatment for removal of volatile organics. At the Skinner site, it appears air stripping is a less desirable process option because it will not address the semi-volatile or inorganic constituents of concern. Also, the presence of elevated levels of calcium, magnesium and iron would result in significant corrosion to the air stripper unless they were removed prior to the air stripper.

7.3.2 Chemical Treatment

Chemical treatment consists of adding a material to the wastestream that will destabilize or react with the existing constituents. Common additives include acids/bases to precipitate inorganics from solution, flocculants such as polymers to coagulate the precipitants, or oxidants such as hydrogen peroxide to oxidize and destroy organic contaminants.

Chemical precipitation/coagulation/flocculation is a commonly practiced wastewater treatment. Generally, the pH of the wastewater is adjusted to a level of minimum solubility for a contaminant. However, in multi-component wastestreams, determination of the optimum pH is sometimes difficult due to the amphoteric nature of inorganic hydroxides. Figure 19 shows the relationship between various inorganic compounds as pH is adjusted. It is clear from this diagram that a single pH will not be optimum for a wastestream that contains multiple contaminants of concern, such as at Skinner. Furthermore, for several of the organics the minimum solubility is still above the proposed effluent standard. While co-precipitation may increase the removal efficiency somewhat, the antagonistic effects of a multicomponent system will likely off-set if not worsen the removal effectiveness. In addition, the limitations discussed in the section on sedimentation would be applicable. As such, it appears that chemical treatment to remove inorganics is not feasible in this instance.

Chemical oxidation of organics involves the use of a strong oxidant, such as hydrogen peroxide, potassium permanganate, or ozone to break down complex organics. While potentially viable, current data suggest that treatment for organics in groundwater of the trench is not required. Further, this process is likely more costly than conventional activated carbon adsorption. Additional investigation of this option, therefore, is not envisioned at this time.

7.3.3 Biological Treatment

Biological treatment consists of using natural or man-made microbes to biochemically degrade organic materials. Three primary mechanisms exist for biological treatment: aerobic, anoxic, and anaerobic. Review of the data from Skinner indicates there is insufficient biodegradable material to sustain any of these processes. This is indicated by the depressed BOD, COD, and TOC concentrations. Therefore, biological treatment will not be considered further.

8.0 RECOMMENDED TREATMENT PROCESS AND DESIGN

Based upon review of the available technologies and considering the proposed effluent standards and estimated composite extracted groundwater quality, a tank for collection of the groundwater followed by a sediment filter and discharge to the East Fork of Mill Creek is recommended. This process has been selected over other unit operations for several reasons. First, this operation is enclosed, resulting in reduced potential for volatile emissions and odors from the system. For removal of solids from the groundwater, it is felt that filtration is preferable to coagulation, flocculation and sedimentation in that it is less complex, produces a more consistent low-solids effluent, and produces a lower volume (higher percent solids) sludge for disposal.

While there are no quantitative data available concerning the expected concentration of suspended solids present in the extracted groundwater, samples collected at the site have exhibited elevated turbidity, such that field filtering was required. Data from the Phase II investigation reported suspended solids concentrations up to 500 mg/l. However, this data may reflect initial well development, and may not be representative of the long-term quantity derived from the interception system. Nevertheless, it does appear that, at least in the initial stages of groundwater extraction, suspended solids may be elevated. Also, the concentrations of iron, calcium, and magnesium in the groundwater indicate supersaturation. Once the groundwater is exposed to the atmosphere, precipitation of these compounds as oxides, hydroxides, and carbonates may occur, further adding to the suspended solids loading. Estimation of the precipitation potential can better be evaluated in the final design of the system. These two factors, taken in conjunction with the nature and characterization of the receiving stream would result in the need to remove suspended solids prior to discharge. While there are no specific numerical criteria established by the Ohio water quality standards for suspended solids, it is likely standards will be established by the regulatory authority under anti-degradation statutes and these standards will not be met by the raw water. As discussed above, an enclosed filtration process such as a sand filter or precoated leaf filter to meet these standards is preferred. Review of the remaining non-specific standards (pH, temperature, etc.) indicate the raw water will be in compliance.

8.1 General Process Description and Future Work

The proposed treatment process is described in the following paragraphs. Water from the sumps in the trench line will be pumped into two 12,000 gallon, steel collection tanks. The tanks will be 12 feet in diameter by 12 feet tall, equipped with 5 hp top-entering mixers for agitation. The tanks' contents will be mixed for three reasons. The primary reason is to prevent settling out of silt or other solids in the tanks, necessitating frequent cleaning. Also, if chemical addition is required in the future, chemicals can be added and mixed in the tanks without significant additional capital equipment. Finally, agitation will reduce the likelihood of freezing during winter months. The tanks will be equipped with mechanical low- and high-level alarms, and water level will be monitored via a differential pressure cell. Water will be pumped from the tanks through a leaf filter precoated with diatomaceous earth. The leaf filter will remove suspended solids from the wastestream to prevent downstream fouling. The leaf filter will be equipped with an effluent disposable cartridge filter, again to ensure the effluent is completely free of suspended solids.

It is proposed that the tankage and filtration system be located near the western end of the trench, close to well GW50. This area provides a level surface with easy access, close to the creek and power supply. As described in Section 5.3.3, sumps will be placed in low points of the interceptor trenches, and the collected water will be pumped via force main or flow by gravity to the collection tankage. The pumping systems will likely consist of float-operated submersible pumps, line drains and siphon breakers to prevent retention of water in the lines and possible freezing. The lines from the sump to the tankage will be buried below the frost line on the landfill side of the trench line so that if breakage occurs, the released water will be collected.

The tanks will be placed on poured concrete foundations with containment walls designed to contain 110% of the volume of one tank. The tanks will not be inside a building. The filter unit, monitoring units, electrical, instrumentation, and control systems, will be housed within a small prefabricated building, which will also provide storage of treatment chemicals, residuals prior to shipment off-site, and maintenance equipment. Note that the building will be constructed with adequate room and access to allow for addition of equipment should the volume or concentration of contaminants increase and require modification of the system. An outfall structure at the stream will be constructed to minimize erosion or damage to the stream bank when effluent is discharged.

The above provides the basic concept of the collection and treatment system. Specific data regarding pump size and specifications, line size, building, filter, and instrumentation and control details will be provided as part of the remedial design. The remedial design will also provide specific information regarding the installation methodology and location of the interceptor and cut-off trenches, sumps, as well as site controls designed to minimize threats to human health and the environment during construction.

8.2 Supplemental Treatment Operations to Address Potential Table 1 Trigger Contaminants

This evaluation is based upon very limited data for both the characterization and quantity of groundwater at the trench line. At this point, the data analysis indicates that treatment to remove organic and inorganic species is not required, and that treatment through on-site tankage is preferred. However, literature correlating the data from well bail tests with the true volumetric production from a trench is limited. Also, the use of six well points to describe the hydraulic and chemical characteristics of a 1400-foot long trench necessitates a number of significant assumptions regarding homogeneity along the trench line and representativeness of the samples. Thus, the final design, subsequent operation, and evaluation of the operation should be performed using the observational method and must recognize the potential for variation from the assumptions contained herein and be flexible enough to address actual conditions. This is true for both the chemical characteristics and volume of water produced once the system begins operation.

If actual production indicates the need for inorganic contaminant removal, it is recommended that a dual-tank, skid mounted, cation/anion exchange system be installed downstream of the filter. The cation segment of the unit will remove multivalent ions, such as calcium, magnesium, iron, lead, and chromium (trivalent), typically to below detection levels. The anion segment will remove arsenic, nitrates, and other anionic species. Influent and effluent conductivity would be monitored by the system, and regeneration of the units would occur when conductivity reaches an operator-specified level.

If it is determined that removal of organics is required, it is recommended that a skid mounted (including pumping system), dual tank activated carbon adsorption system be installed. The wastewater would be pumped through the carbon for removal of organics, followed by a final disposable cartridge filter to remove carbon fines, prior to discharge to the East Fork of Mill Creek.

9.0 LONG TERM GROUNDWATER MONITORING PLAN

The final design of the groundwater interception system will include specifications for the long term groundwater sampling and analysis program to monitor the effectiveness of the remedy. The monitoring system will be installed as part of the remedial action.

9.1 Groundwater Monitoring System

The point-of-compliance for the downgradient groundwater control system will be the collection system alignment between the landfill and East Fork of Mill Creek. The groundwater monitoring system will consist of monitoring wells installed at selected locations between the groundwater collection trench and East Fork of Mill Creek. The wells will be installed for monitoring groundwater characteristics in the unsaturated sediments above the bedrock, between the collection trench and East Fork. The final locations and construction specifications for the monitoring wells will be determined during the remedial design of the groundwater interception system.

9.2 Sampling Frequency

Samples will be obtained quarterly from the compliance monitoring wells during the initial operations of the groundwater collection system. The sampling frequency may be modified depending on the results of the quarterly sampling. The mechanism for modifying the sampling frequency will be the demonstration that the concentrations of contaminants listed in the SOW Table 1 have decreased below the allowable discharge limits and that groundwater downgradient of the collection system does not contain concentrations which exceed the trigger levels as modified in this report.

9.3 Parameters

Samples obtained in the compliance monitoring wells will be analyzed for the SOW Table 1 parameters. The trigger level concentrations for the parameters as modified in Section 4.0 will be compared with concentrations of samples obtained from compliance monitoring wells.

9.4 Data Analysis

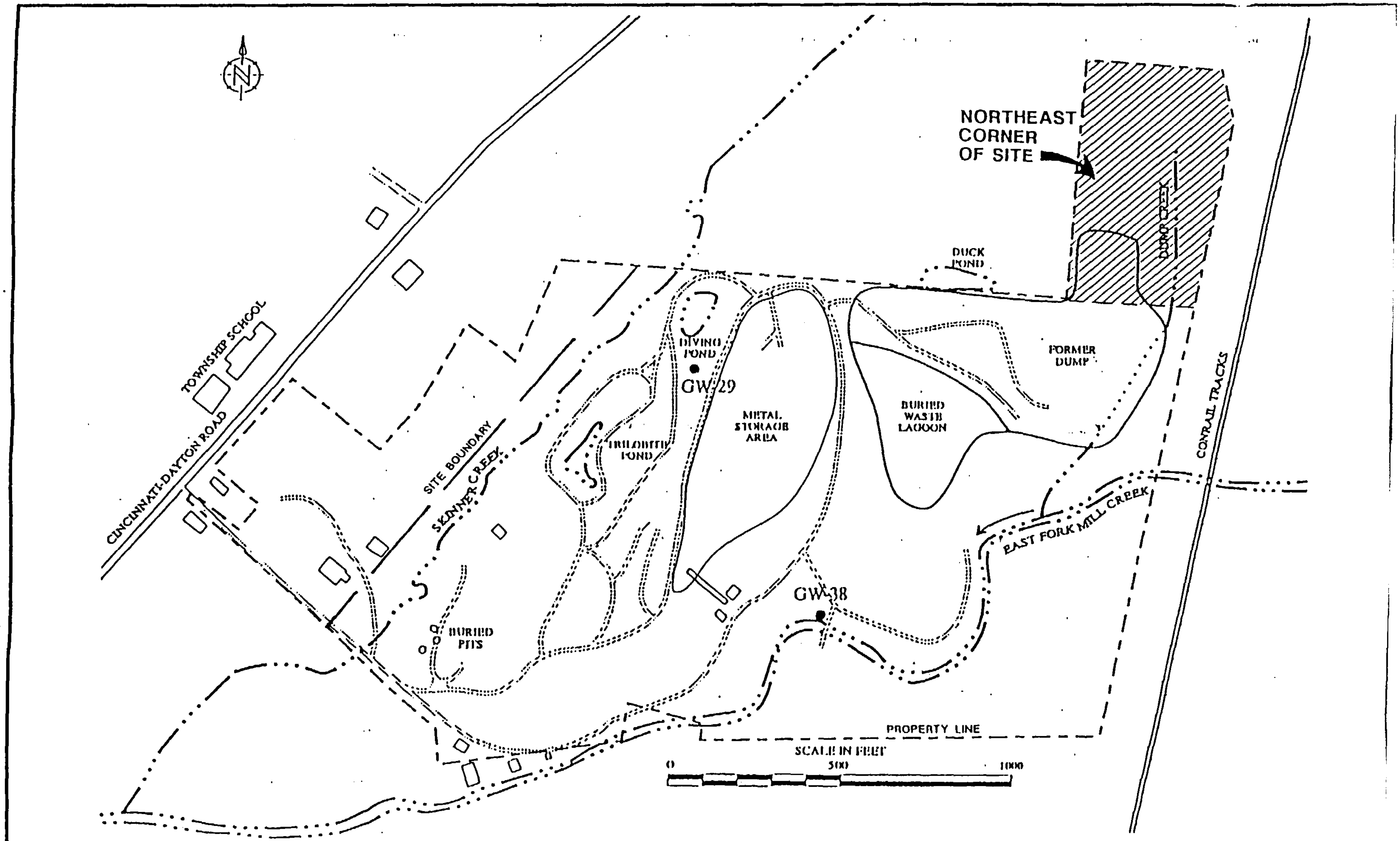
Samples collected from the Quarterly Groundwater Monitoring Program will be compared both to the previous data collected from the quarterly program and the trigger levels. Data collected from the treatment system discharge will be compared to both the historical discharge data and the SOW Table 1 parameters (as modified by Section 4.0), as well as the discharge limits.

All data collected from both the Quarterly Groundwater Monitoring Program and the treatment system discharge will be recorded on a spread sheet. Each parameter detected from both the quarterly program and the treatment system discharge data will be graphically analyzed to determine if any trend through time exist within the data.

9.5 Criteria for Completion of Collection

According to the Statement of Work for Remedial Design, "The respondents may file a petition for termination of the operation of the Groundwater Collection System with the U.S. EPA after demonstrating that the concentrations of all contaminants listed in Table 1 in the water which is withdrawn from the collection system have decreased to concentrations less than the applicable NPDES discharge limits, and that groundwater downgradient of the collection and treatment does not contain contaminants at concentrations which exceed the trigger levels". The respondents shall petition U.S. EPA to cease collection of groundwater upon demonstration that all wells and collected groundwater are below the Modified Table 1 standards for one year or four consecutive sampling events, whichever is longer.

Figures



LEGEND
- Selected well locations as referred to in text

Skinner Landfill Site
West Chester, Butler County, Ohio

SITE PLAN

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NO. 72680.200 FIGURE 1

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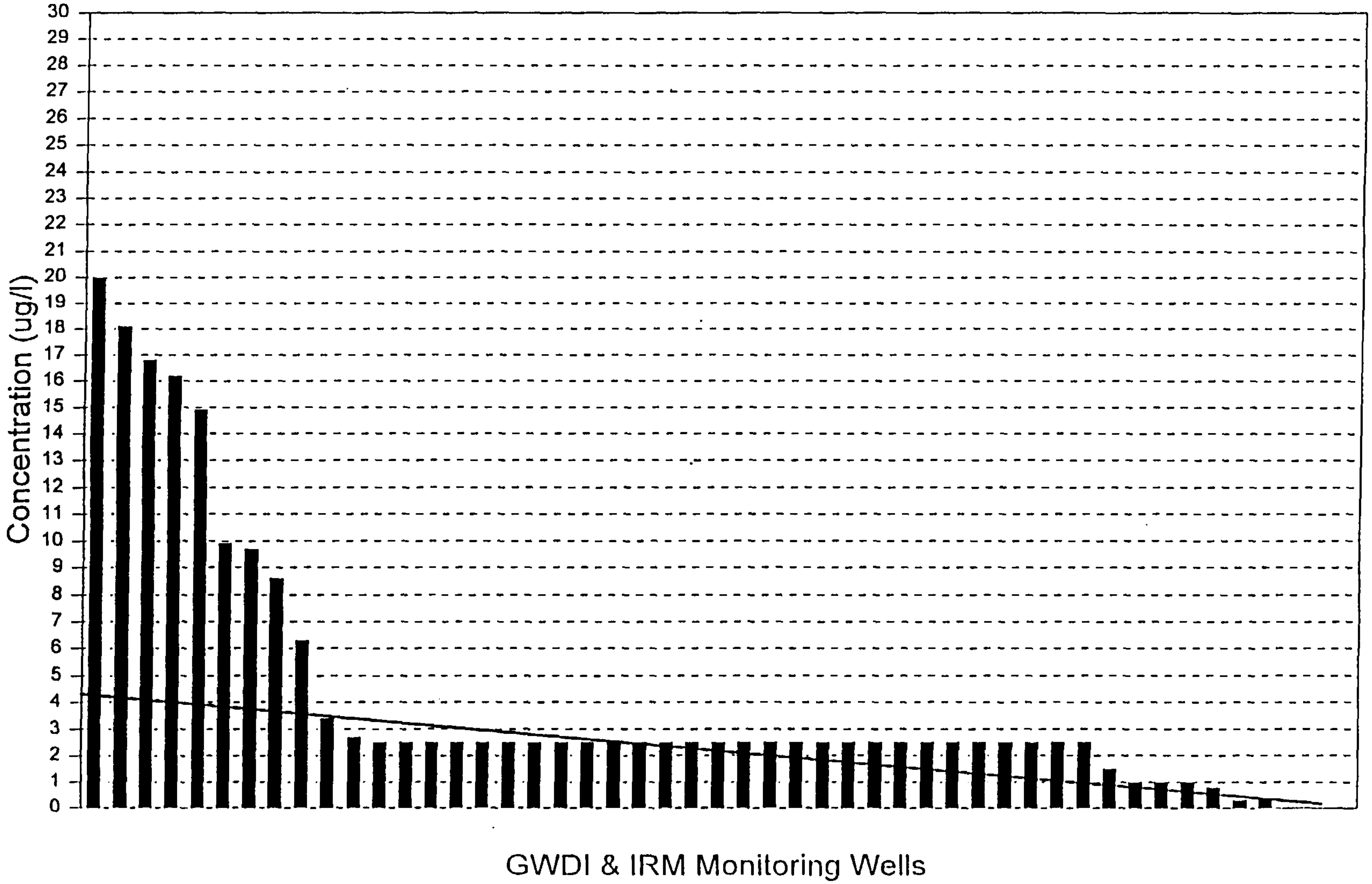
Figure 3 Groundwater RD Investigation

Graphical Data Evaluation - Arsenic

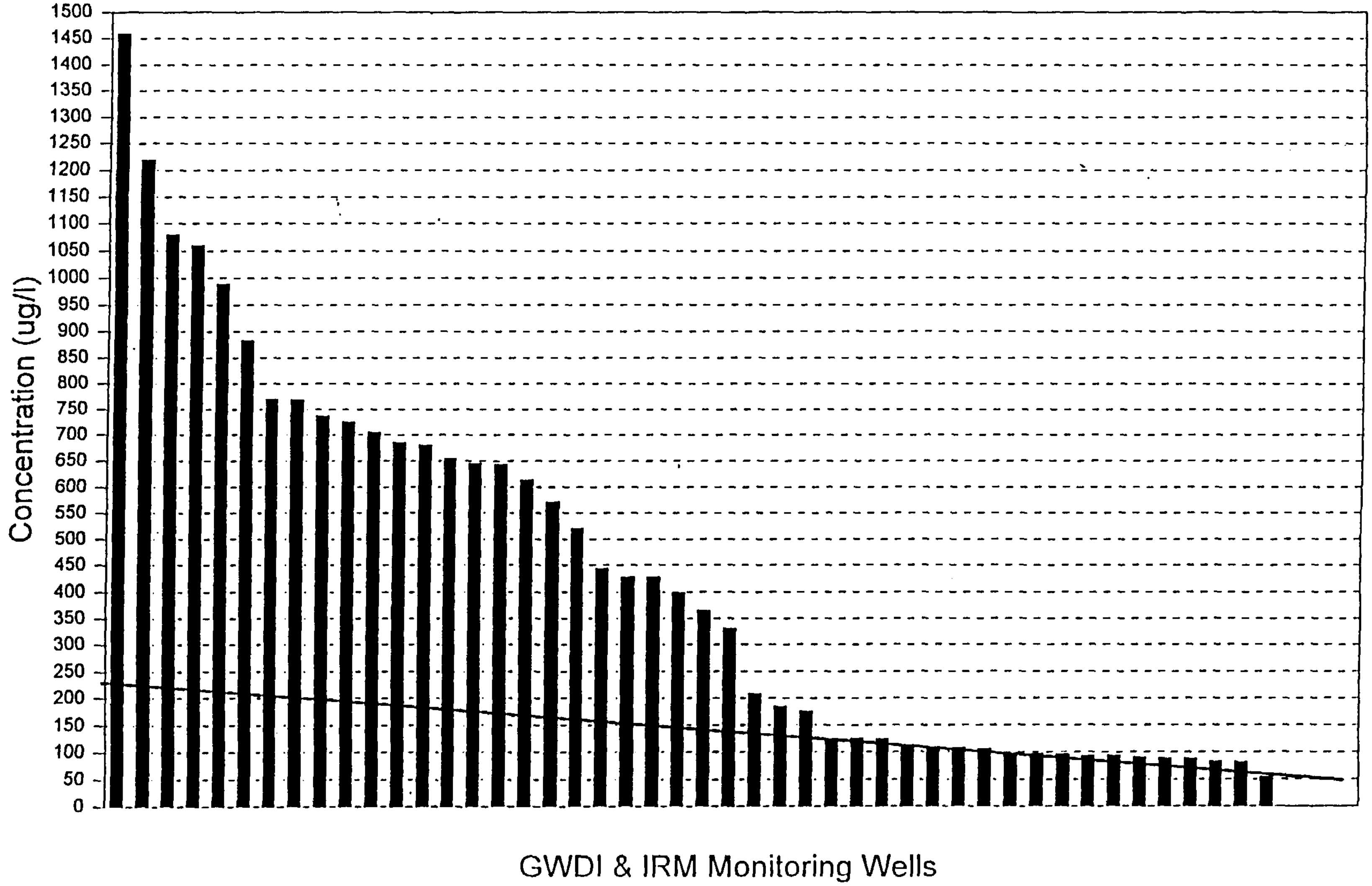


BACKGROUND LEVEL = 4.3 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 4 Groundwater RD Investigation

Graphical Data Evaluation - Barium

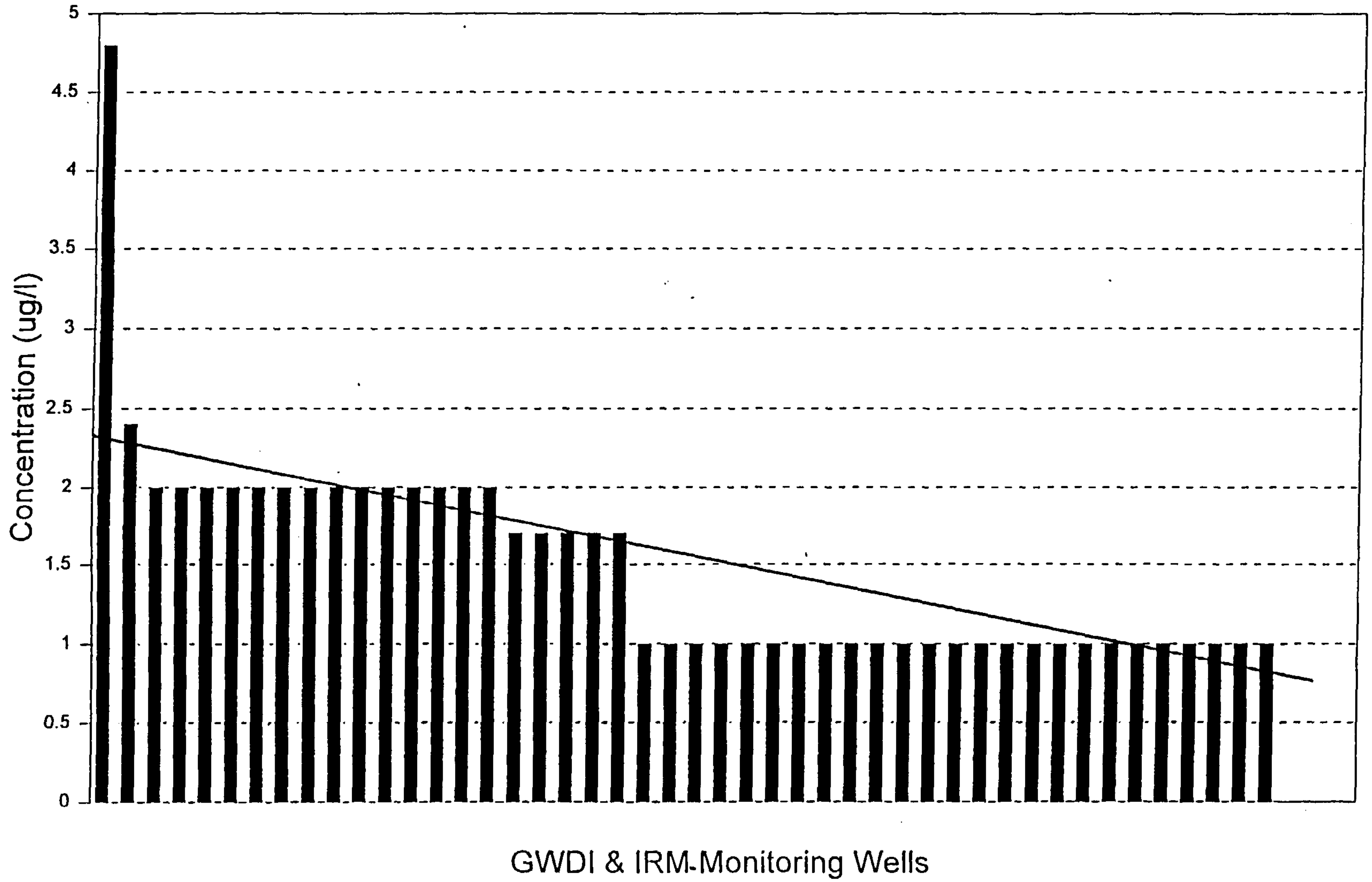


BACKGROUND LEVEL = 235 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 5 Groundwater RD Investigation

Graphical Data Evaluation - Cadmium

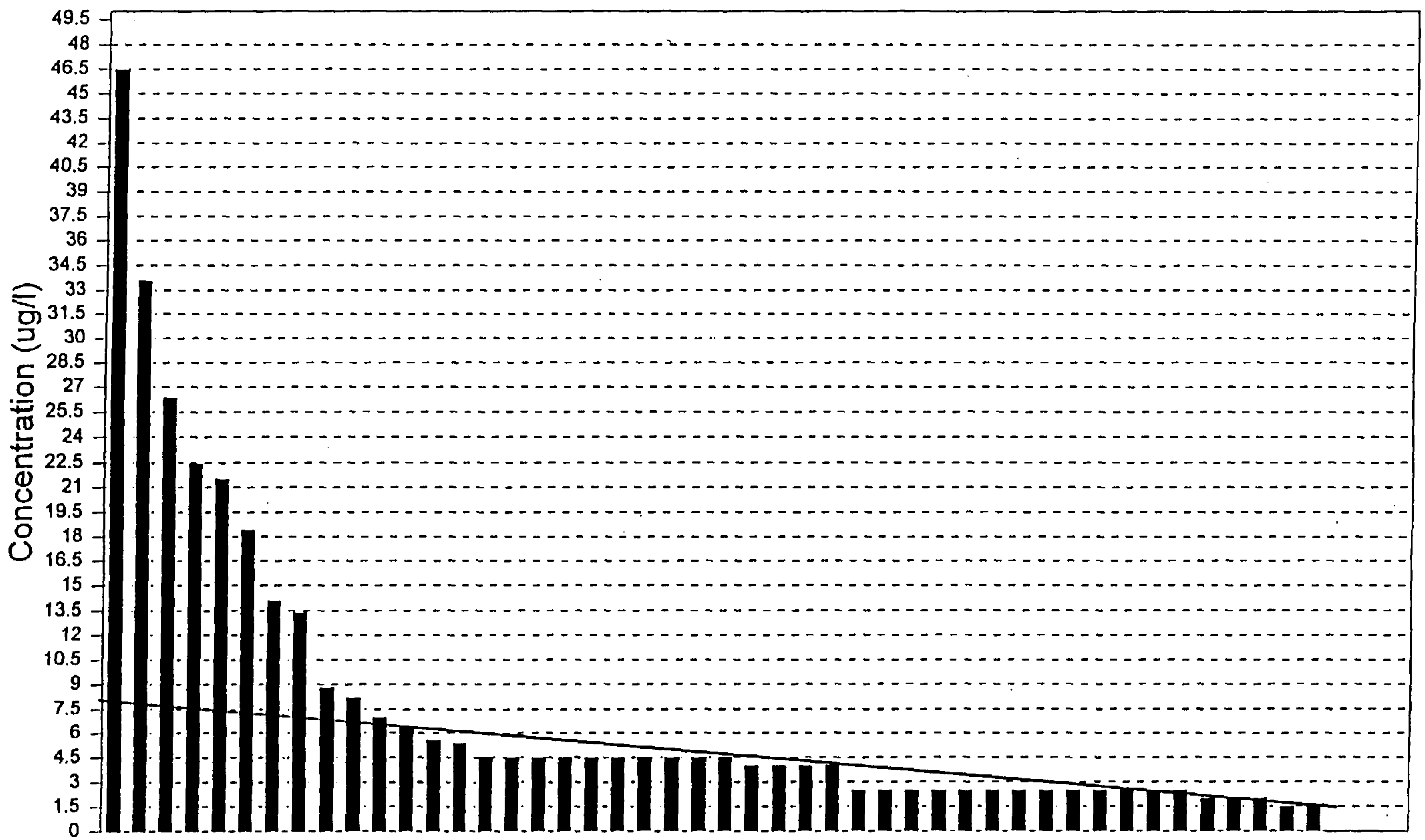


BACKGROUND LEVEL = 2.35 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 6 Groundwater RD Investigation

Graphical Data Evaluation - Chromium



BACKGROUND LEVEL = 7.6 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

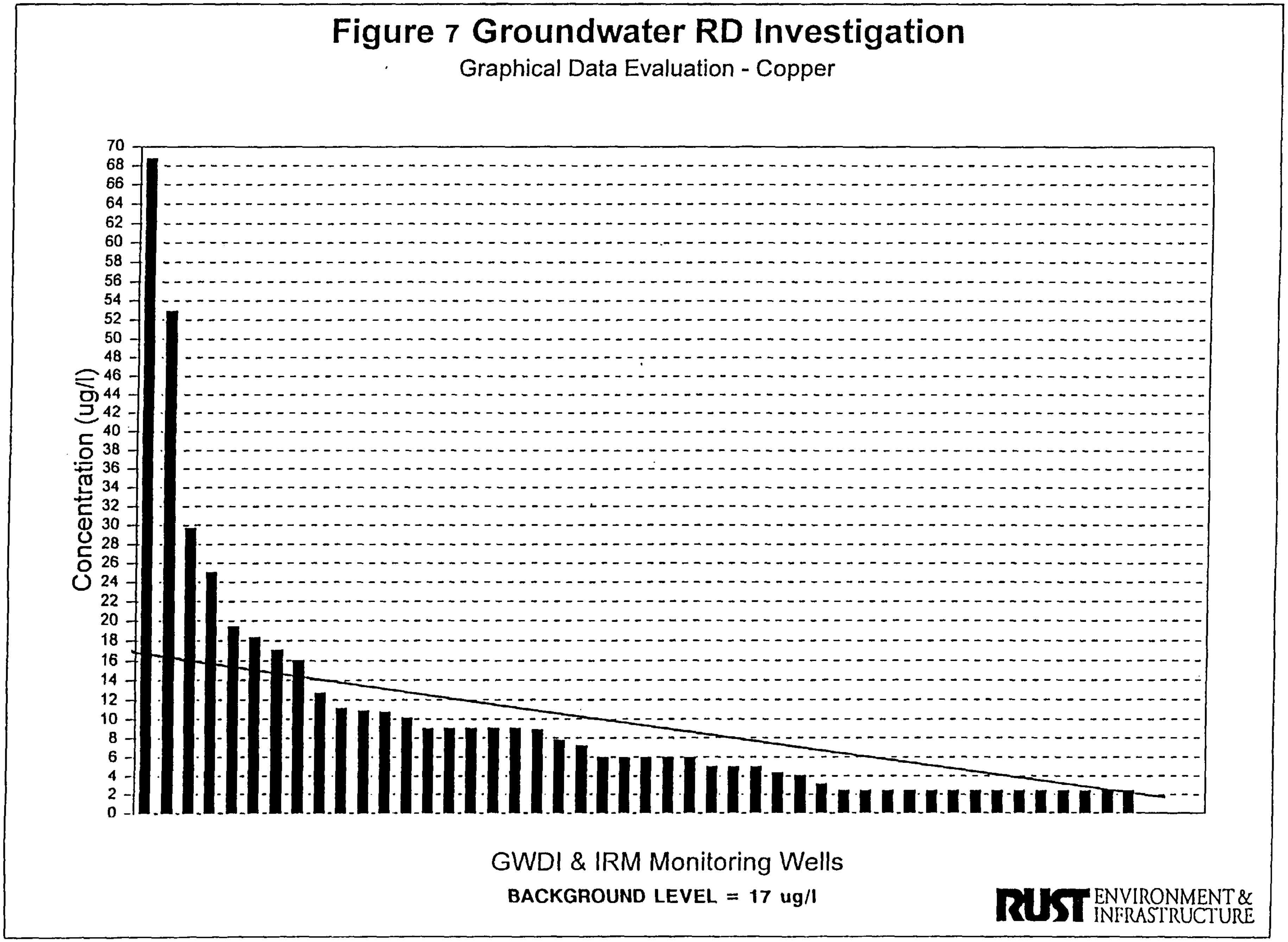
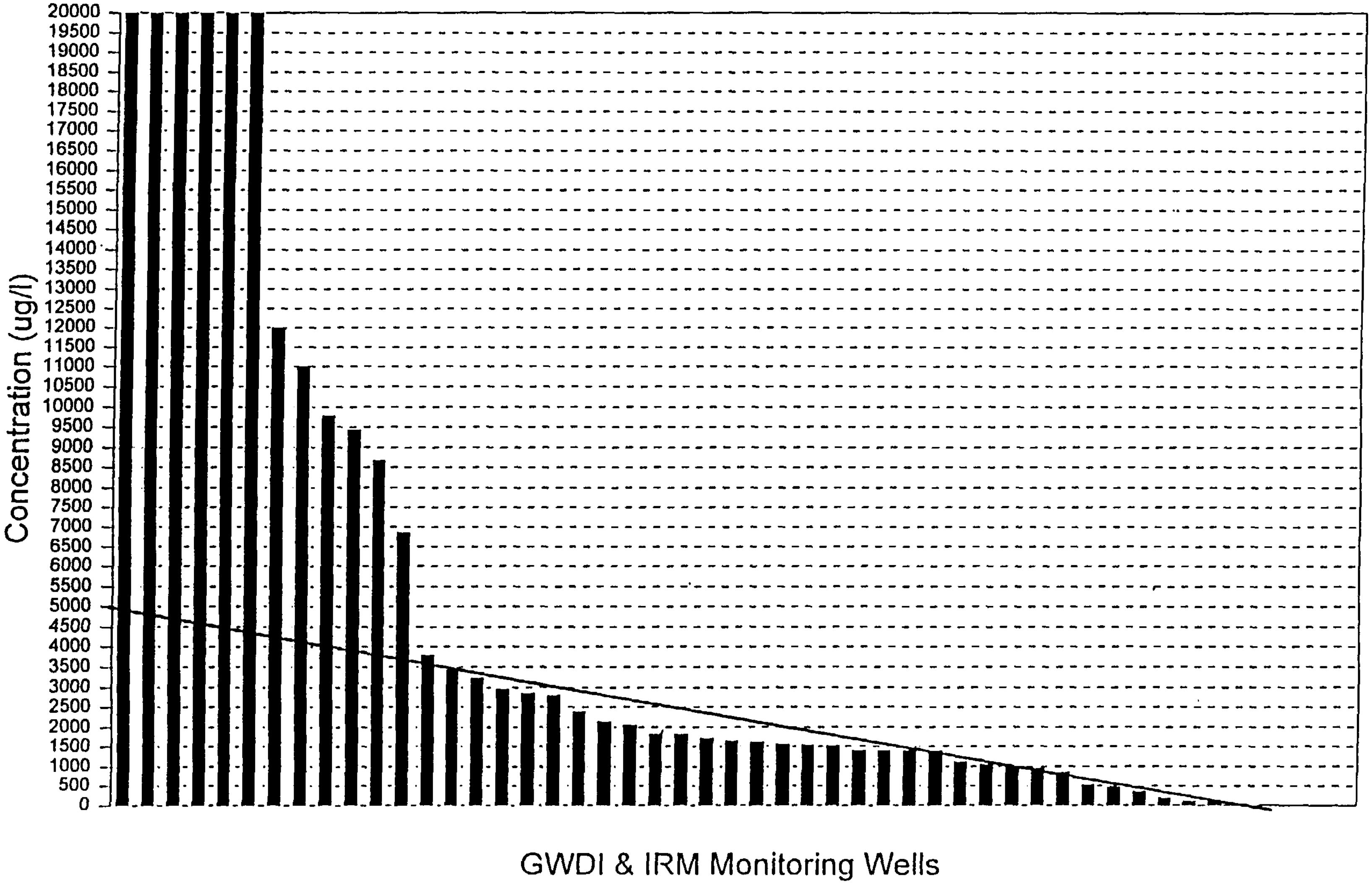


Figure 7 Groundwater RD Investigation
Graphical Data Evaluation - Copper
Concentration (ug/l)
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
GWDI & IRM Monitoring Wells
BACKGROUND LEVEL = 17 ug/l
RUST ENVIRONMENT & INFRASTRUCTURE

Figure 8 Groundwater RD Investigation

Graphical Data Evaluation - Iron

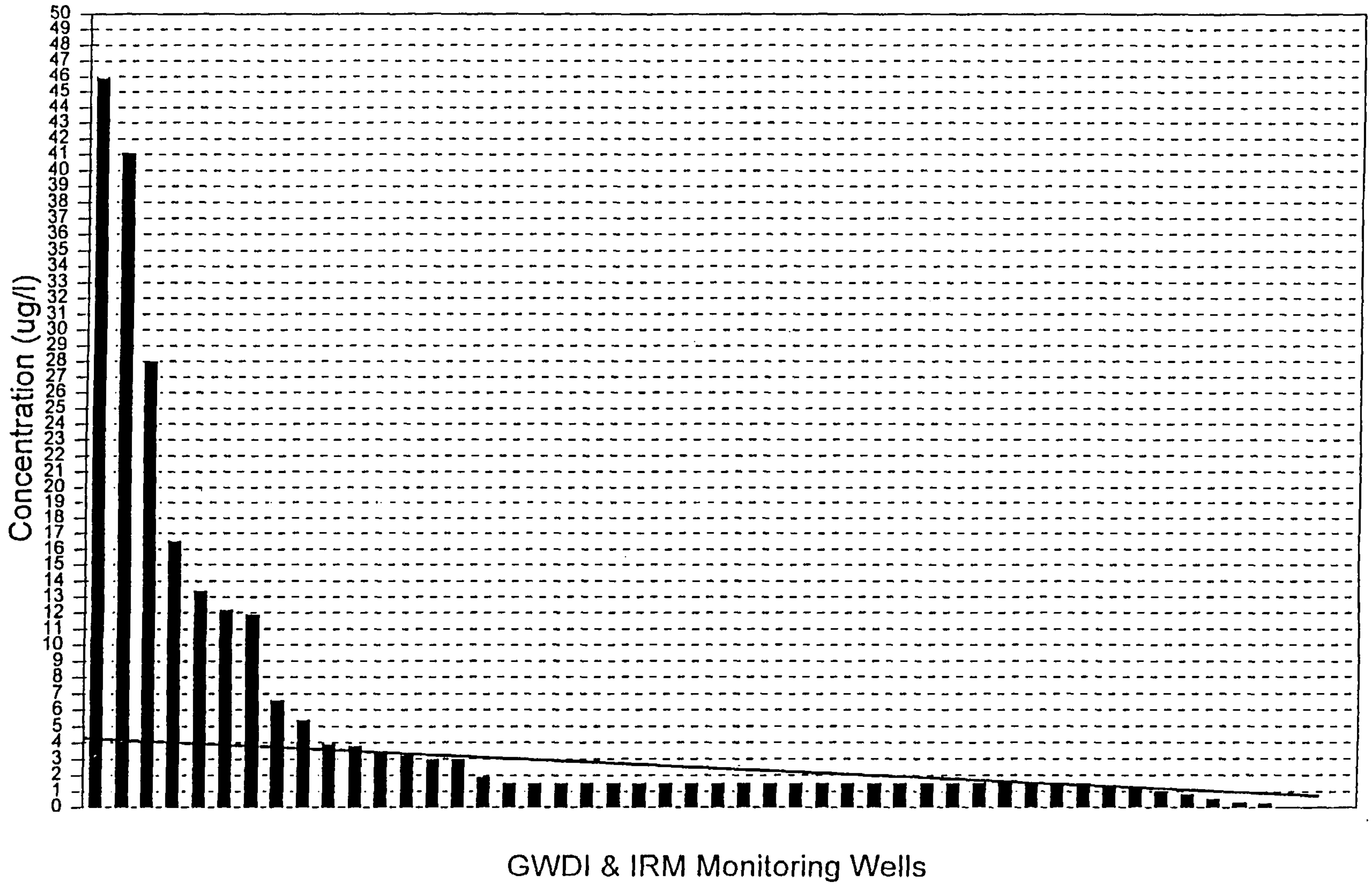


BACKGROUND LEVEL = 5000 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 9 Groundwater RD Investigation

Graphical Data Evaluation - Lead

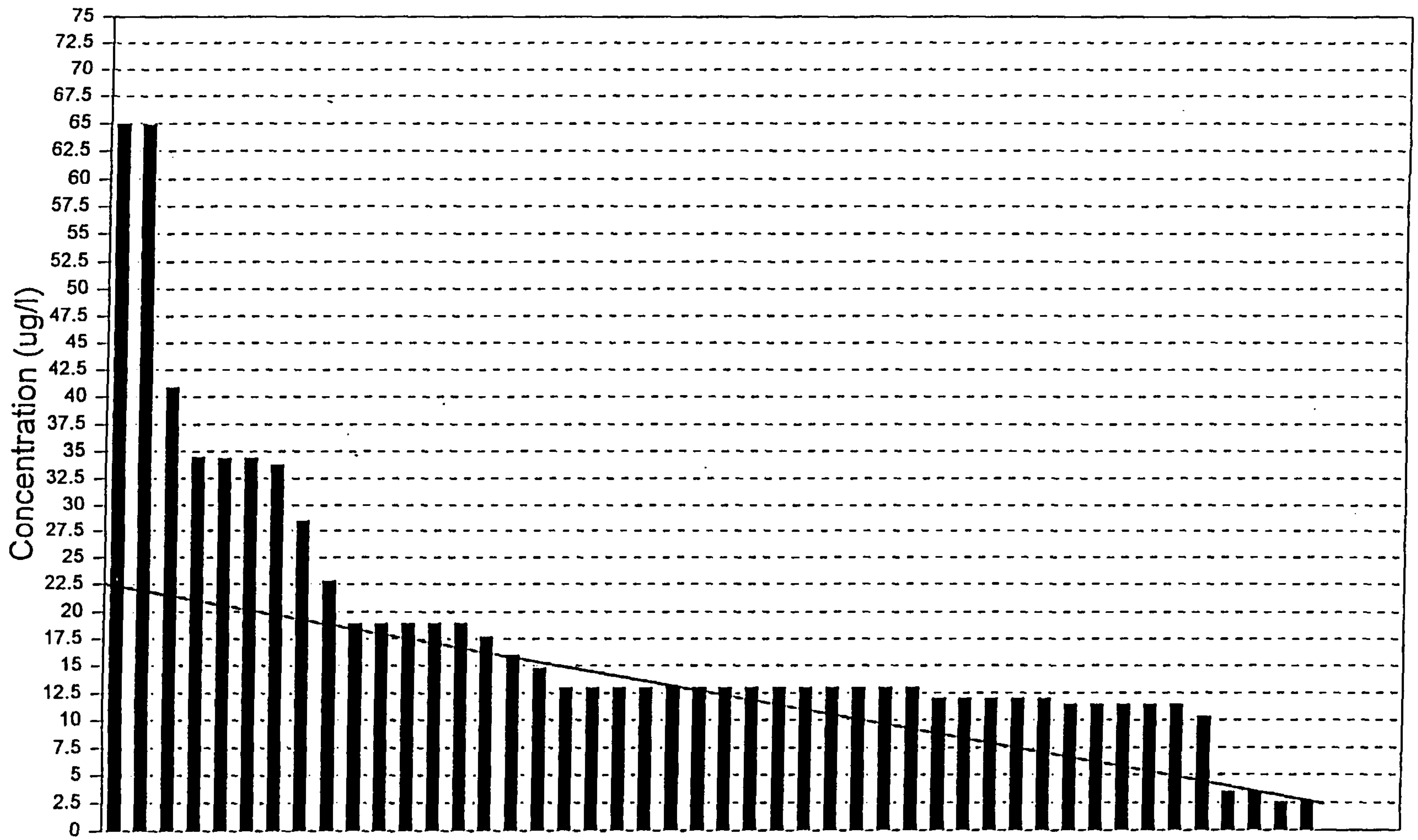


BACKGROUND LEVEL = 4.2 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 10 Groundwater RD Investigation

Graphical Data Evaluation - Nickel



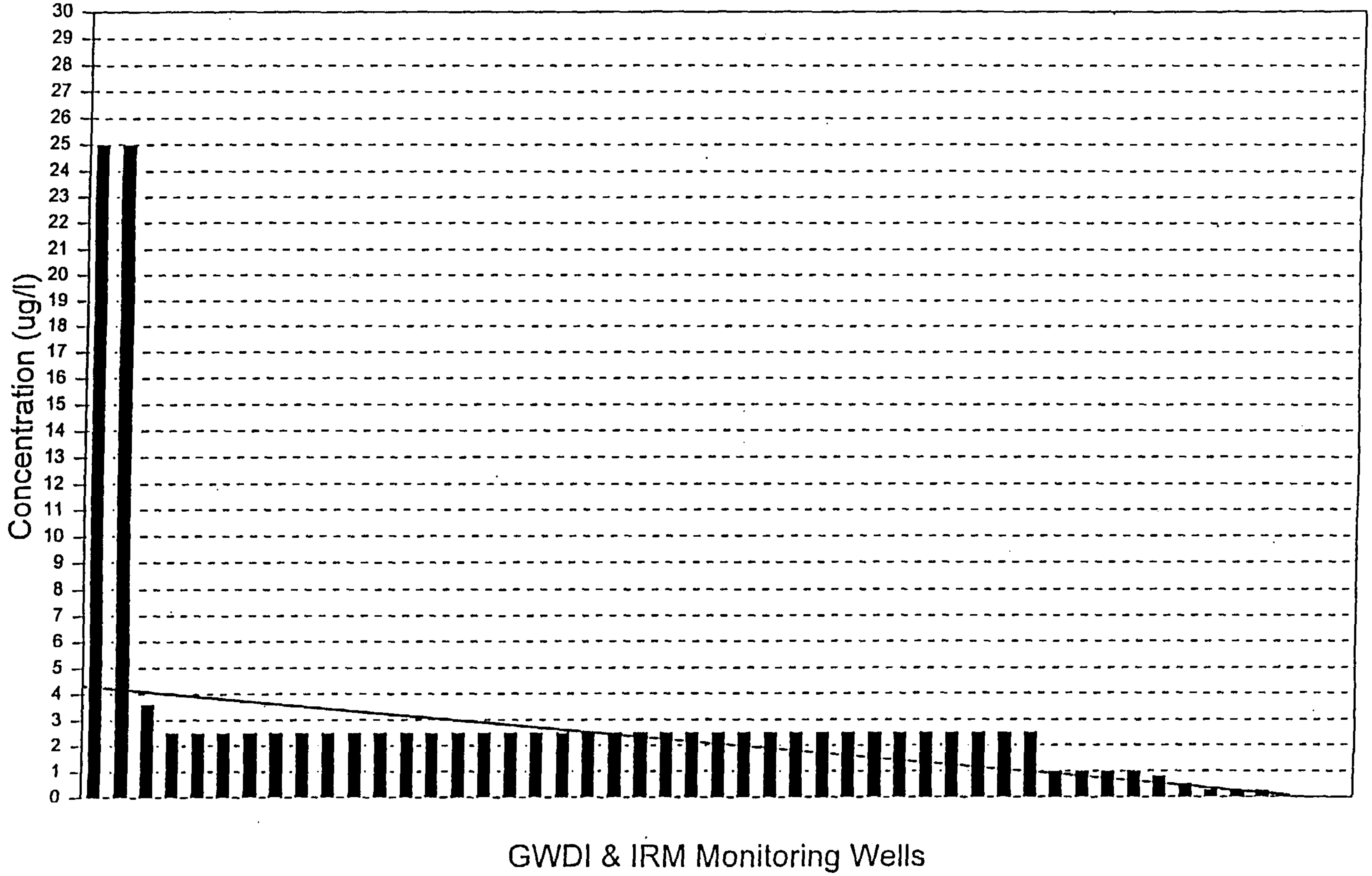
GWDI & IRM Monitoring Wells

BACKGROUND LEVEL = 22.5 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 11 Groundwater RD Investigation

Graphical Data Evaluation - Thallium

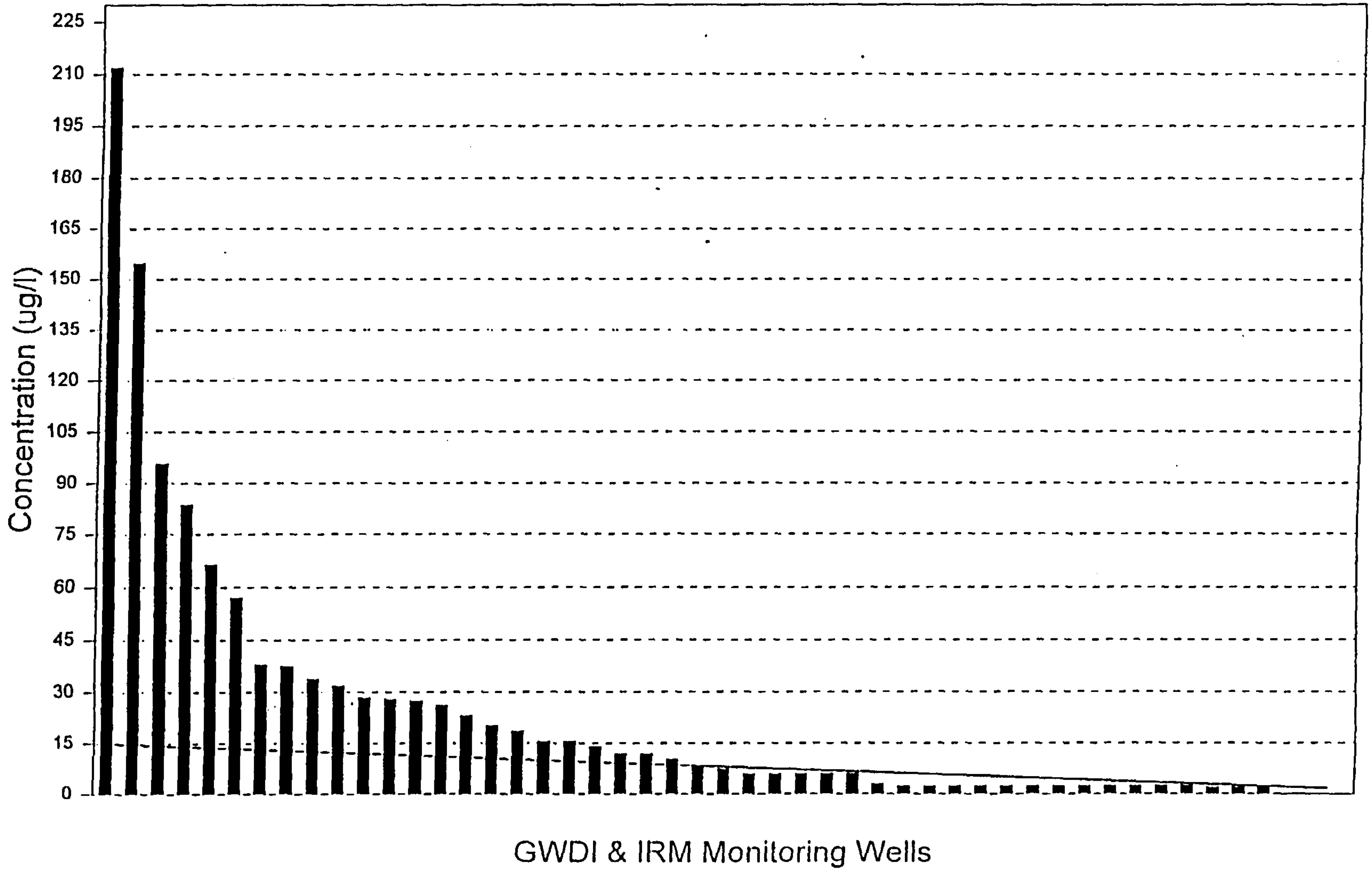


BACKGROUND LEVEL = 4.2 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 12 Groundwater RD Investigation

Graphical Data Evaluation - Zinc

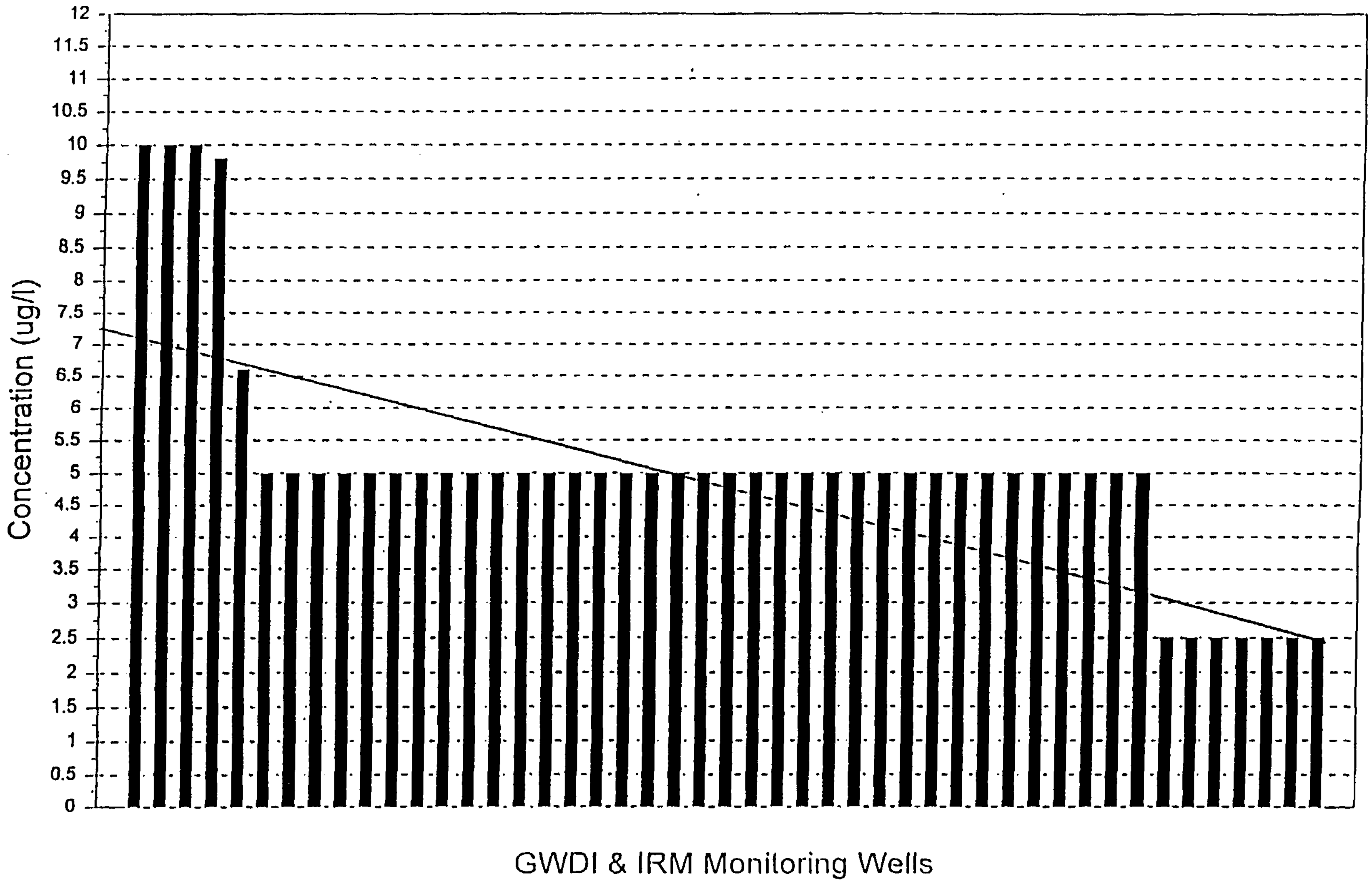


BACKGROUND LEVEL = 15 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

Figure 13 Groundwater RD Investigation

Graphical Data Evaluation - Cyanide



BACKGROUND LEVEL = 7.25 ug/l

RUST ENVIRONMENT & INFRASTRUCTURE

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NO. OF ITEMS	**1**		
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PRP			
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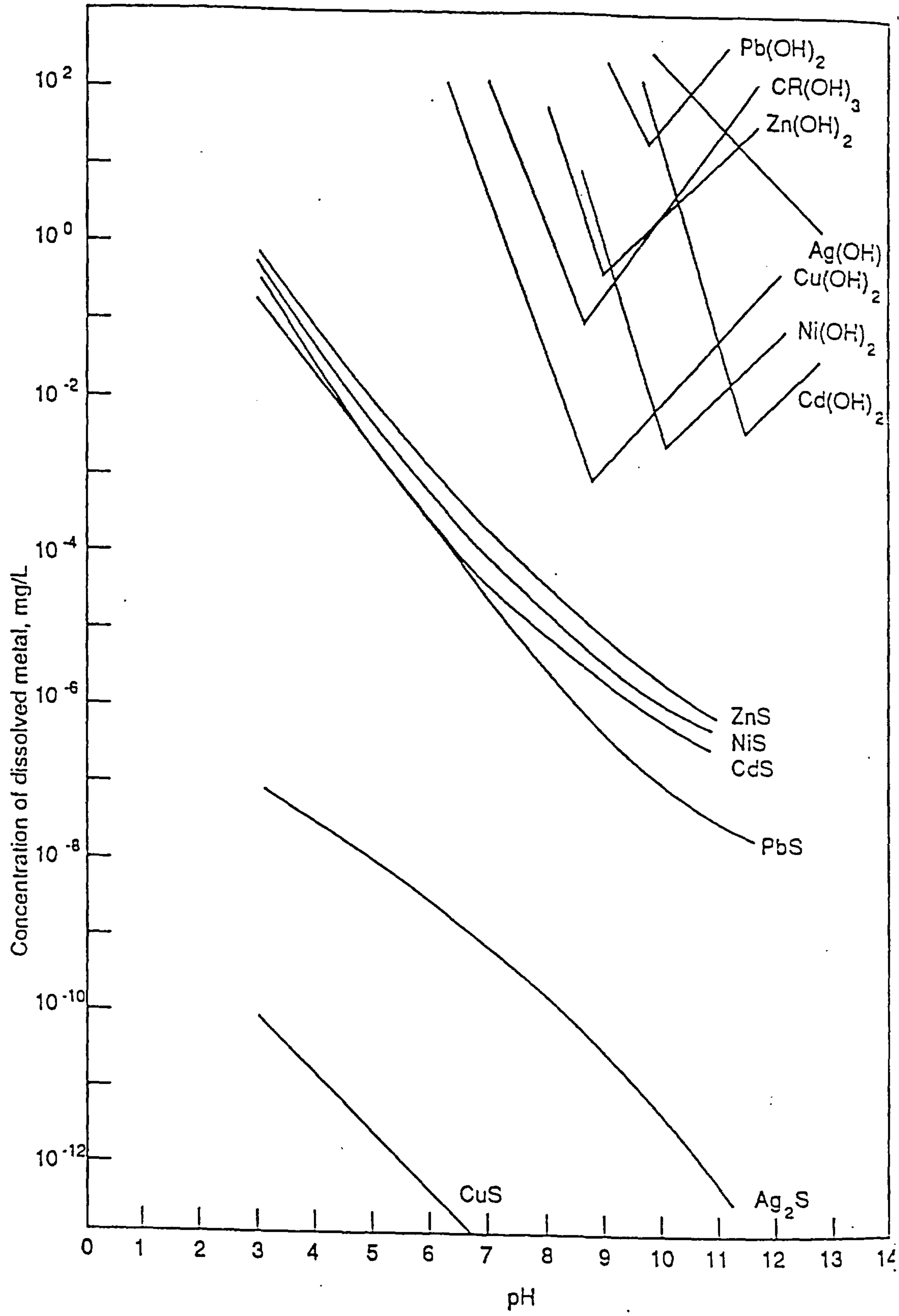

FIG. 9.9 Solubility of metal hydroxides and sulfides (49).

Tables

Skinner Landfill - Groundwater Remedial Design Investigation

Definition of Terms, Notes and Abbreviations Used in Tables

Existing Trigger - Trigger Level as defined in Table 1 of the RD SOW
Revised Trigger - Trigger Level as modified by the GWDI
CAS No. - Chemical Abstracts Services Number
Conc. - Concentration
CRDL - Contract Required Detection Limit
Max. Maximum value found for a specific parameter
Diss. - Dissolved (passes a 0.45 micron filter) fraction
Temp., C - Temperature in degrees Celsius
Cond., mu/cm - Conductivity, milliohms per centimeter
pH, su - pH, standard units
ntu - nephelometric turbidity units
IRM - Interim Remedial Measures
RDI - Groundwater Remedial Design Investigation
PQL - Practical Quantitation Limit (equivalent to CRDL)
mg/l - milligrams per liter (parts per million)
ug/l - micrograms per liter (parts per billion)

Notes

All numerical values in ug/l unless otherwise stated
Blank cells indicate a parameter was not detected in that well
Where a parameter was not detected in any well, the parameter was not shown in the tables
Where no parameters were detected in an individual well, the well was not shown
Wells GW19, GW24, GW27, and B8 were dry
Well GW20 could not be accessed due to damaged
Well GW12 was not located
Wells GW06 and GW7R did not provide enough sample to complete inorganic analyses. Well GW7R is not shown in Tables 2 and 5 (Round 5) for this reason

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Table 1

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Well Sampling - Organic "Hits"

CAS No	Compound	CRDL	Max.	Existing Trigger	SAMPLE GWB5 CONC	SAMPLE GW06 CONC	SAMPLE GW7R CONC	SAMPLE GW09 CONC	SAMPLE GW10 CONC	SAMPLE GW17 CONC	SAMPLE GW18 CONC	SAMPLE GW26 CONC
79-34-5	1,1,2,2-Tetrachloroethane	10	10	107	10							
79-00-5	1,1,2-Trichloroethane	10	130	418	130							
75-34-3	1,1-Dichloroethane	10	45		45							
107-06-2	1,2-Dichloroethane	10	220	5	220							
540-59-0	1,2-Dichloroethene (total)**	10	26	70	26							
78-87-5	1,2-Dichloropropane	10	580	5	580	11	15				22	16
67-64-1	Acetone	10	16								16	
71-43-2	Benzene	10	100	5	10					100		
108-90-7	Chlorobenzene	10	23	26						23		
67-66-3	Chloroform	10	120	79	120							
8-88-3	Toluene	10	10	1000	10							
9-01-6	Trichloroethene	10	52	5	52							
75-01-4	Vinyl Chloride	10	46	2	46							

111-44-4	bis(2-Chloroethyl)Ether	10	41	13.6	41							
117-81-7	bis(2-Ethylhexyl)phthalate	10	50	49	50		32	75	79		140	

NOTES:

Samples collected 10/25-10/28, 1994
All results ug/l
Wells GW 19, GW24, GW27, and B8 were Dry
Well GW20 could not be accessed due to damage
Well GW12 was not located
No parameters were detected above CRDL in wells GW11, GW25, GW28, GW30, GW31, and GW38
Parameters for which there was no detection in any wells or for which there is no trigger level are not shown
For clarity, parameters that were not detected are not shown.
** Existing Trigger for cis isomer is 70 ug/l, trans isomer, is 100 ug/l CRDL for total 1,2 dichloroethene only

Table 2

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Wells - Inorganic "Hits"

			Existing	SAMPLE B5	SAMPLE GW09		SAMPLE GW10		SAMPLE GW11		SAMPLE GW17	
Compound	Max.	CRDL	Trigger	Total	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.
Aluminum	1540	200			335.0		855.0					
Arsenic	20.4	10	5	14.9							20.0	20.4
Barium	884	200	1000	55.1(J)	884.0	881.0					210.0	215.0
Calcium	255000	5000		234,000.0	88,400.0	88,400.0	243,000.0	238,000.0	251,000.0	255,000.0	116,000.0	115,000.0
Cyanide	10	10	5.2				10.0					
Iron	12000	100	1	9,780.0	2,390.0	1,590.0	2,860.0		472.0	478.0	12,000.0	12,000.0
Lead	5.4	3	3.2				5.4	4.3				
Magnesium	91200	5000		50,400.0	39,500.0	39,300.0	91,200.0	89,400.0	81,700.0	80,800.0	38,600.0	37,700.0
Manganese	4540	15		659.0	35.4	22.8	591.0	495.0	4,430.0	4,540.0	922.0	916.0
Potassium	54900	5000		5,740.0	3870.0(J)	4460.0(J)	54,900.0	53,300.0	39,200.0	39,700.0	35,000.0	34,400.0
Sodium	428000	5000		43,600.0	54,100.0	54,000.0	159,000.0	156,000.0	178,000.0	182,000.0	64,200.0	62,800.0

Notes:
All results ug/l
Samples collected 10/25 - 10/28, 1994.
Wells GW19, GW24, GW27, and B8 were dry.
Well GW20 could not be accessed due to damage.
Well GW12 was not found.
For clarity, parameters not detected are not shown.
Wells GW06, GW7R - insufficient water for inorganics.
Well B5 - enough water to do totals only.
"J" designation indicates parameter is estimated
Antimony, beryllium, cadmium, chromium, cobalt,
copper, mercury, nickel, selenium, silver, thallium,
vanadium, and zinc were not detected in any wells

Table 2 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Wells - Inorganic "Hits"

			Existing	SAMPLE GW18		SAMPLE GW25		SAMPLE GW26		SAMPLE GW28		SAMPLE GW30	
Compound	Max.	CRDL	Trigger	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.
Aluminum	1540	200				1,020.0				714.0			
Arsenic	20.4	10	5		11.1								
Barium	884	200	1000					366.0	331.0			332.0	336.0
Calcium	255000	5000		182,000.0	185,000.0	130,000.0	133,000.0	74,700.0	78,000.0	42,500.0	42,600.0	63,300.0	63,700.0
Cyanide	10	10	5.2										
Iron	12000	100	1	1,130.0	160.0	1,710.0	99.2(J)	203.0		855.0		360.0	437.0
Lead	5.4	3	3.2										
Magnesium	91200	5000		48,600.0	48,600.0	37,200.0	38,100.0	38,300.0	40,100.0	18,700.0	19,100.0	29,200.0	29,400.0
Manganese	4540	15		646.0	648.0	200.0	166.0	621.0	504.0	36.6	23.4	55.5	56.5
Potassium	54900	5000		35,700.0	37,800.0	5,510.0	5,740.0	17,300.0	16,900.0	17,300.0	17,700.0	11,900.0	12,500.0
Sodium	428000	5000		90,100.0	89,300.0	45,600.0	46,700.0	171,000.0	160,000.0	428,000.0	421,000.0	136,000.0	136,000.0

Notes:
All results ug/l
Samples collected 10/25 - 10/28, 1994.
Wells GW19, GW24, GW27, and B8 were dry.
Well GW20 could not be accessed due to damage.
Well GW12 was not found.
For clarity, parameters not detected are not shown.
Wells GW06, GW7R - insufficient water for inorganics.
Well B5 - enough water to do totals only.
"J" designation indicates parameter is estimated
Antimony, beryllium, cadmium, chromium, cobalt,
copper, mercury, nickel, selenium, silver, thallium,
vanadium, and zinc were not detected in any wells

Table 2 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Wells - Inorganic "Hits"

Compound	Max.	CRDL	Existing Trigger	SAMPLE GW31 Total	SAMPLE GW31 Diss.	SAMPLE GW38 Total	SAMPLE GW38 Diss.
Aluminum	1540	200		1,540.0			
Arsenic	20.4	10	5				
Barium	884	200	1000	572.0	534.0	771.0	719.0
Calcium	255000	5000		114,000.0	10,600.0	74,000.0	77,000.0
Cyanide	10	10	5.2				
Iron	12000	100	1	2,810.0	100.0	1,580.0	1,490.0
Lead	5.4	3	3.2	3.3			
Magnesium	91200	5000		43,600.0	41,500.0	38,700.0	39,800.0
Manganese	4540	15		309.0	241.0	66.5	90.4
Potassium	54900	5000		5,940.0	5,250.0	7,940.0	9,980.0
Sodium	428000	5000		53,100.0	50,700.0	155,000.0	207,000.0

Notes:
All results ug/l
Samples collected 10/25 - 10/28, 1994.
Wells GW19, GW24, GW27, and B8 were dry.
Well GW20 could not be accessed due to damage.
Well GW12 was not found.
For clarity, parameters not detected are not shown.
Wells GW06, GW7R - insufficient water for inorganics.
Well B5 - enough water to do totals only.
"J" designation indicates parameter is estimated
Antimony, beryllium, cadmium, chromium, cobalt,
copper, mercury, nickel, selenium, silver, thallium,
vanadium, and zinc were not detected in any wells

Table 3

Skinner Landfill - Groundwater Remedial Design Investigation
Field Data

Well	Sampling Event	Temp, C	Cond mu/cm	pH su	Turbidity ntu	Remarks
GW-06	IRM	14.0	0.793	7.79	37	FILTERED TOTAL METALS
	RDI	12.5	0.824	7.55	>200 (VISUAL)	NO DISSOLVED METALS
GW-7R	IRM	17.6	1.265	6.81	73.4	ONLY 3/4 OF METALS
	RDI	13.8	1.258	7.27	>200 (VISUAL)	COLLECTED (FILTERED)
GW-09	IRM	15.9	1.010	7.30	4.51	FILTERED DISSOLVED ONLY
	RDI	13.5	0.964	7.51	37.2	FILTERED DISSOLVED ONLY
GW-10	IRM	16.8	2.170	7.63	50.9	FILTERED BOTH METALS
	RDI	14.6	2.340	7.04	19.74	FILTERED ONLY DISSOLVED
GW-11	RDI	16.7	2.490	6.89	>200	YELLOWISH - FILTERED BOTH
GW-17	RDI	15.8	1.420	6.67	15.9	FILTERED DISSOLVED ONLY
GW-18	RDI	14.1	1.651	7.33	>200	4ppm HIT IN BOREHOLE - FILTERED BOT
GW-19	RDI					DRY W/ BLACK INK ON PROBE
GW-25	RDI	13.8	1.065	7.54	>200	FILTERED BOTH
GW-26	RDI	11.9	1.446	8.05	94.1	FILTERED BOTH
GW-28	IRM	14.3	2.070	7.81	>200	1 VOL SAMPLE ONLY
	RDI	11.6	2.080	7.75	>200 (VISUAL)	DUPLICATE SAMPLE
GW-30	RDI	13.1	1.201	7.45	>200	FILTERED BOTH
GW-31	RDI	13.6	1.182	7.42	>200	VERY TURBID MUDDY GRAY BLOW TORCH VAPORS IN AIR DURING SAMPLING - FILTERED BOTH
GW-38	IRM	14.4	1.545	7.52	63.2	FILTERED DISSOLVED ONLY
	RDI	11.7	1.502	7.46	3.25	FILTERED DISSOLVED ONLY
B-5	RDI	16.3	1.430	7.08	>200	FILTERED BOTH

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Table 4

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Well Sampling - Organic "Hits", GWDI vs. Historical

			Existing	Sample GWB5					Sample GW06					Sample GW7R				
CAS No	Compound	Maximum	Trigger	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
71-55-6	1,1,1-Trichloroethane	16	88	Well not installed			16											
79-34-5	1,1,2,2-Tetrachloroethane	10	107	until Round 4			6	10										
79-00-5	1,1,2-Trichloroethane	130	418				55	130										
107-06-2	1,2-Dichloroethane	220	5				180	220										
540-59-0	1,2-Dichloroethene (total)**	35	70				35	26						27	11	10	5	
78-87-5	1,2-Dichloropropane	580	5				370	580										15
78-93-3	2-Butanone	12	7.1															
71-43-2	Benzene	950	5				21	10										
108-90-7	Chlorobenzene	45	26															
67-66-3	Chloroform	120	79				85	120										
100-41-4	Ethylbenzene	20	62															
127-18-4	Tetrachloroethene	3	5				3											
108-88-3	Toluene	44	1000				24	10									35	
79-01-6	Trichloroethene	71	5				71	52										
75-01-4	Vinyl Chloride	48	2				48	46										
1330-20-7	Xylene (total)	100	10000				17											
95-50-1	1,2-Dichlorobenzene	6	11				6											
541-73-1	1,3-Dichlorobenzene	13	600				13											
106-46-7	1,4-Dichlorobenzene	11	75															
111-44-4	bis(2-Chloroethyl)Ether	240	13.6				73	41										
117-81-7	bis(2-Ethylhexyl)phthalate	140	49					50										32
91-20-3	Naphthalene	64	44				14											
85-01-8	Phenanthrene	11	6.3									11						
108-95-2	Phenol	13	370															

Note: All results in ug/l
For clarity, parameters not detected are not shown
** Existing trigger for cis isomer is 70 ug/l, trans isomer is 100 ug/l, CRDL for total only
Wells GW19, GW24, GW27, and B8 were Dry, GW12 not located, GW20 damaged
No parameters were detected above CRDL in Wells GW24, GW28, GW39, GW38
Wells GW19, GW20, and GW24 were added for historical data,
but were not part of the GWDI sampling

Round 1 - 5/23/86 (Phase I RI)
Round 2 - 8/21/86 (Phase I RI)
Round 3 - 7/28/87(Phase I RI)
Round 4 - 5/7/90 (Phase II RI)
Round 5 - 10/10/94 (GWDI)

Table 4 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Well Sampling - Organic "Hits", GWDI vs. Historical

CAS No	Compound	Maximum	Existing Trigger	Sample GW09					Sample GW10					Sample GW11				
				1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
71-55-6	1,1,1-Trichloroethane	16	88															
79-34-5	1,1,2,2-Tetrachloroethane	10	107															
79-00-5	1,1,2-Trichloroethane	130	418															
107-06-2	1,2-Dichloroethane	220	5														5	
540-59-0	1,2-Dichloroethene (total)**	35	70															
78-87-5	1,2-Dichloropropane	580	5															
78-93-3	2-Butanone	12	7.1															
71-43-2	Benzene	950	5															
108-90-7	Chlorobenzene	45	26															
67-66-3	Chloroform	120	79															
100-41-4	Ethylbenzene	20	62															
127-18-4	Tetrachloroethene	3	5															
108-88-3	Toluene	44	1000															
79-01-6	Trichloroethene	71	5															
75-01-4	Vinyl Chloride	48	2															
1330-20-7	Xylene (total)	100	10000															
95-50-1	1,2-Dichlorobenzene	6	11															
541-73-1	1,3-Dichlorobenzene	13	600															
106-46-7	1,4-Dichlorobenzene	11	75															
111-44-4	bis(2-Chloroethyl)Ether	240	13.6							30								
117-81-7	bis(2-Ethylhexyl)phthalate	140	49					75					79					
91-20-3	Naphthalene	64	44															
85-01-8	Phenanthrene	11	6.3															
108-95-2	Phenol	13	370															

Note: All results in ug/l
For clarity, parameters not detected are not shown
** Existing trigger for cis isomer is 70 ug/l, trans isomer is 100 ug/l, CRDL for total only
Wells GW19, GW24, GW27, and B8 were Dry, GW12 not located, GW20 damaged
No parameters were detected above CRDL in Wells GW24, GW28, GW39, GW38
Wells GW19, GW20, and GW24 were added for historical data,
but were not part of the GWDI sampling

Round 1 - 5/23/86 (Phase I RI)
Round 2 - 8/21/86 (Phase I RI)
Round 3 - 7/28/87(Phase I RI)
Round 4 - 5/7/90 (Phase II RI)
Round 5 - 10/10/94 (GWDI)

Table 4 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Well Sampling - Organic "Hits", GWDI vs. Historical

CAS No	Compound	Maximum	Existing Trigger	GW17 Sample 1	GW17 2	GW17 3	GW17 4	GW17 5	GW18 Sample 1	GW18 2	GW18 3	GW18 4	GW18 5	GW19 Sample 1	GW19 2	GW19 3	GW19 4	GW19 5
71-55-6	1,1,1-Trichloroethane	16	88															
79-34-5	1,1,2,2-Tetrachloroethane	10	107															
79-00-5	1,1,2-Trichloroethane	130	418															
107-06-2	1,2-Dichloroethane	220	5															
540-59-0	1,2-Dichloroethene (total)**	35	70															
78-87-5	1,2-Dichloropropane	580	5										22					
78-93-3	2-Butanone	12	7.1														12	
71-43-2	Benzene	950	5	340			690	100	950			890						
108-90-7	Chlorobenzene	45	26					23				27						
67-66-3	Chloroform	120	79															
100-41-4	Ethylbenzene	20	62															
127-18-4	Tetrachloroethene	3	5															
108-88-3	Toluene	44	1000														0.7	
79-01-6	Trichloroethene	71	5															
75-01-4	Vinyl Chloride	48	2															
1330-20-7	Xylene (total)	100	10000															
95-50-1	1,2-Dichlorobenzene	6	11															
541-73-1	1,3-Dichlorobenzene	13	600															
106-46-7	1,4-Dichlorobenzene	11	75				8					11						
111-44-4	bis(2-Chloroethyl)Ether	240	13.6															
117-81-7	bis(2-Ethylhexyl)phthalate	140	49										140					
91-20-3	Naphthalene	64	44				2											
85-01-8	Phenanthrene	11	6.3															
108-95-2	Phenol	13	370									13						

Note: All results in ug/l
For clarity, parameters not detected are not shown
** Existing trigger for cis isomer is 70 ug/l, trans isomer is 100 ug/l, CRDL for total only
Wells GW19, GW24, GW27, and B8 were Dry, GW12 not located, GW20 damaged
No parameters were detected above CRDL in Wells GW24, GW28, GW39, GW38
Wells GW19, GW20, and GW24 were added for historical data,
but were not part of the GWDI sampling

Round 1 - 5/23/86 (Phase I RI)
Round 2 - 8/21/86 (Phase I RI)
Round 3 - 7/28/87(Phase I RI)
Round 4 - 5/7/90 (Phase II RI)
Round 5 - 10/10/94 (GWDI)

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Table 4 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Existing Well Sampling - Organic "Hits", GWDI vs. Historical

			Existing	Sample GW20					Sample GW24					Sample GW26				
CAS No	Compound	Maximum	Trigger	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
71-55-6	1,1,1-Trichloroethane	16	88					Damage						Well not installed				
79-34-5	1,1,2,2-Tetrachloroethane	10	107					Well						until Round 4				
79-00-5	1,1,2-Trichloroethane	130	418					could										
107-06-2	1,2-Dichloroethane	220	5				7	not be										
540-59-0	1,2-Dichloroethene (total)**	35	70					sampled										
78-87-5	1,2-Dichloropropane	580	5				21											
78-93-3	2-Butanone	12	7.1															
71-43-2	Benzene	950	5	280		400	410											
108-90-7	Chlorobenzene	45	26				45											
67-66-3	Chloroform	120	79				32											
100-41-4	Ethylbenzene	20	62				20					5						
127-18-4	Tetrachloroethene	3	5															
108-88-3	Toluene	44	1000				44					15						
79-01-6	Trichloroethene	71	5				2											
75-01-4	Vinyl Chloride	48	2				8											
1330-20-7	Xylene (total)	100	10000	34		100	14											
95-50-1	1,2-Dichlorobenzene	6	11															
541-73-1	1,3-Dichlorobenzene	13	600															
106-46-7	1,4-Dichlorobenzene	11	75															
111-44-4	bis(2-Chloroethyl)Ether	240	13.6	180		240	130											
117-81-7	bis(2-Ethylhexyl)phthalate	140	49															
91-20-3	Naphthalene	64	44			64	2											
85-01-8	Phenanthrene	11	6.3															
108-95-2	Phenol	13	370															

Note: All results in ug/l
For clarity, parameters not detected are not shown
** Existing trigger for cis isomer is 70 ug/l, trans isomer is 100 ug/l, CRDL for total only
Wells GW19, GW24, GW27, and B8 were Dry, GW12 not located, GW20 damaged
No parameters were detected above CRDL in Wells GW24, GW28, GW39, GW38
Wells GW19, GW20, and GW24 were added for historical data,
but were not part of the GWDI sampling

Round 1 - 5/23/86 (Phase I RI)
Round 2 - 8/21/86 (Phase I RI)
Round 3 - 7/28/87(Phase I RI)
Round 4 - 5/7/90 (Phase II RI)
Round 5 - 10/10/94 (GWDI)

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Table 5

Skinner Landfill- Groundwater Remedial Design Investigation
Historical Metals Data

		Well	B5	B5	GW06	GW06	GW06	GW07	GW07	GW07	GW07	GW07	B8	GW09	GW09	GW09	GW09	GW09	GW09
		Round	4	5	1	2	4	1	2	3	3	4	4	1	1	2	4	5	5
	Existing	Filtered	A	U	F	F	A	F	F	F	F	A	A	F	F	F	A	U	F
Compound	Trigger	Max																	
Aluminum		55,600.0	48		773	67	11	0	49	96	23	11	48	0	0	32	48	335	
Antimony	30.0	64.8	49														46		
Arsenic	5.0	61.2	17	15	0	0	7	0	0	0	0	1	1	11	0	0	1		
Barium	1,000.0	5,950.0	140	55	180	70	5,950	109	96	101	97	281	53	537	41	447	795	884	881
Cadmium	1.1	2.5	2		0	0	3	0	0	0	0	1	2	0	0	0	2		
Calcium		269,000.0	197,000	234,000													84,400	88,400	88,400
Chromium	11.0	137.0	3		23	0	4	0	6	0	0	4	3	0	0	0	3		
Cobalt		94.0	5		0	0	4	0	0	0	0	4	5	0	0	0	5		
Copper	12.0	163.0	2		0	8	5	0	10	6	8	2	4	0	2	5	2		
Iron	1.0	19,100.0	8,040	9,780													1,820	2,390	1,590
Lead	3.2	94.0	5		0	0	1	4	0	0	0	1	2	0	0	12	1		
Magnesium		91,200.0	43,700	50,400													39,000	39,500	39,300
Manganese		4,540.0	363	659	0	18	8	578	2,650	484	466	833	50	54	0	65	19	35	23
Mercury	0.0	2.9															0		
Nickel	96.0	150.0	8		0	0	5	0	16	0	0	5	8	0	0	0	8		
Potassium		54,900.0	5,050	5,740													4,340	3,870	4,460
Sodium		428,000.0	37,200	43,600													60,100	54,100	54,000
Vanadium		135.0	5		0	0	15	0	0	0	0	15	2	0	2	0	2		
Zinc	86.0	441.0	62		10	6	1	0	19	25	22	17	4	7	0	20	4		
Cyanide	5.2	23.5	5		0	0	5	0	0	0	0	5	5	0	0	0	5		

Notes
- All Results ug/l
- F - Filtered
- U - Unfiltered
- A - Unknown
- Round 1 - 5/23/86 (Phase I RI)
- Round 2 - 8/21/86 Phase I RI)
- Round 3 - 7/28/87 (Phase I RI)
- Round 4 - 5/7/90 Phase II RI)
- Round 5 - 10/10/94 (GWDI)
- For clarity, parameters not detected are not shown

Beryllium, Selenium, Silver, and Thallium not detected in any wells

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Table 5 (cont.)

Skinner Landfill- Groundwater Remedial Design Investigation

Historical Metals Data

		Well	GW10	GW10	GW10	GW10	GW10	GW10	GW10	GW11	GW11	GW11	GW11	GW11	GW11
		Round	1	1	2	4	4	5	5	1	1	2	4	5	5
	Existing	Filtered	U	F	F	A	A	U	F	U	F	F	A	U	F
Compound	Trigger	Max													
Aluminum		55,600.0	24,600	0	36	48	48	855		6,170	0	36	48		
Antimony	30.0	64.8					27						65		
Arsenic	5.0	61.2	20	0	0	1	1			4	0	0	2		
Barium	1,000.0	5,950.0	650	501	752	40	40			103	82	114	55		
Cadmium	1.1	2.5	0	0	0	2	2			0	0	0	2		
Calcium		269,000.0					107,000	243,000	238,000				269,000	251,000	255,000
Chromium	11.0	137.0	43	0	0	3	3			13	0	7	3		
Cobalt		94.0	24	9	8	5	5			0	0	11	5		
Copper	12.0	163.0	75	0	6	8	8			19	0	12	4		
Iron	1.0	19,100.0					69	2,860					153	472	478
Lead	3.2	94.0	82	0	0	1	5	5	4	9	7	0	1		
Magnesium		91,200.0					32,600	91,200	89,400				54,900	81,700	80,800
Manganese		4,540.0	1,270	428	602	204	216	591	495	484	14	4,270	35	4,430	4,540
Mercury	0.0	2.9											3		
Nickel	96.0	150.0	62	31	29	8	8			0	0	57	8		
Potassium		54,900.0					29,100	54,900	53,300				21,200	39,200	39,700
Sodium		428,000.0					53,500	159,000	156,000				104,000	178,000	182,000
Vanadium		135.0	60	0	0	5	4			0	0	0	7		
Zinc	86.0	441.0	309	1	11	8	8			94	0	23	16		
Cyanide	5.2	23.5	0	0	0	5	5	10		0	0	11	5		

Notes
- All Results ug/l
- F - Filtered
- U - Unfiltered
- A - Unknown
- Round 1 - 5/23/86 (Phase I RI)
- Round 2 - 8/21/86 Phase I RI)
- Round 3 - 7/28/87 (Phase I RI)
- Round 4 - 5/7/90 Phase II RI)
- Round 5 - 10/10/94 (GWDI)
- For clarity, parameters not detected are not shown

Beryllium, Selenium, Silver, and Thallium not detected in any wells

Table 5 (cont.)

Skinner Landfill- Groundwater Remedial Design Investigation
Historical Metals Data

Well			GW17	GW17	GW17	GW17	GW17	GW17	GW18	GW18	GW18	GW18	GW18	GW19	GW19	GW19	GW19
Round			1	2	2	4	5	5	1	2	4	5	5	1	1	2	4
Filtered			F	F	F	A	U	F	F	F	A	U	F	U	F	F	A
Compound	Existing Trigger	Max															
Aluminum		55,600.0	0	36	41	11			0	0	11			55,600	0	75	48
Antimony	30.0	64.8															
Arsenic	5.0	61.2	11	12	0	42	20	20	26	0	50		11	25	0	0	9
Barium	1,000.0	5,950.0	157	143	140	209	210	215	219	108	204			562	58	98	718
Cadmium	1.1	2.5	0	0	0	1			0	0	1			0	0	0	2
Calcium		269,000.0				97,800	116,000	115,000			92,600	182,000	185,000				
Chromium	11.0	137.0	0	0	0	4			4	5	4			137	8	6	3
Cobalt		94.0	0	0	0	4			3	0	4			94	0	0	5
Copper	12.0	163.0	0	8	6	2			0	6	2			106	0	4	2
Iron	1.0	19,100.0				19,100	12,000	12,000			18,300	1,130	160				
Lead	3.2	94.0	0	0	0	1			0	0	1			94	0	0	5
Magnesium		91,200.0				32,400	38,600	37,700			29,500	48,600	48,600				
Manganese		4,540.0	1,434	1,330	1,310	1,430	922	916	2,621	475	1,350	646	648	4,050	33	182	476
Mercury	0.0	2.9				0											
Nickel	96.0	150.0	0	13	11	5			0	9	5			100	0	0	8
Potassium		54,900.0				41,000	35,000	34,400			51,500	35,700	37,800				
Sodium		428,000.0				69,800	64,200	62,800			73,600	90,100	89,300				
Vanadium		135.0	0	0	0	14			0	0	12			135	0	0	5
Zinc	86.0	441.0	12	83	86	14			0	17	14			283	0	7	7
Cyanide	5.2	23.5	0	0	0	5			0	0	5			0	0	0	5

Notes
All Results ug/l
F - Filtered
U - Unfiltered
A - Unknown
Round 1 - 5/23/86 (Phase I RI)
Round 2 - 8/21/86 Phase I RI)
Round 3 - 7/28/87 (Phase I RI)
Round 4 - 5/7/90 Phase II RI)
Round 5 - 10/10/94 (GWDI)
For clarity, parameters not detected
are not shown
Beryllium, Selenium, Silver, and Thallium
not detected in any wells

Table 5 (cont.)

Skinner Landfill- Groundwater Remedial Design Investigation
Historical Metals Data

Compound	Existing Trigger	Max	GW20	GW20	GW20	GW20	GW20	GW24	GW25	GW25	GW26	GW26	GW26	GW27	GW28	GW28	GW28
Round			1	1	2	3	4	4	5	5	4	5	5	4	4	5	5
Filtered			U	F	F	F	A	A	U	F	A	U	F	A	A	U	F
Aluminum		55,600.0	45,700	0	545	0	48	7	1,020		11			48	17	714	
Antimony	30.0	64.8													24		
Arsenic	5.0	61.2	51	19	32	48	61	2			1			1	2		
Barium	1,000.0	5,950.0	694	957	1,080	597	193	64			127	366	331	175	45		
Cadmium	1.1	2.5	0	0	0	0	2	1			1			2	1		
Calcium		269,000.0							130,000	133,000	60,700	74,700	78,000		28,400	42,500	42,600
Chromium	11.0	137.0	101	0	6	0	3	4			4			3	2		
Cobalt		94.0	57	0	18	0	5	2			4			5	2		
Copper	12.0	163.0	163	0	4	0	2	9			2			7	6		
Iron	1.0	19,100.0							1,710	99		203			44	855	
Lead	3.2	94.0	79	4	0	0	1	11			1			2	28		
Magnesium		91,200.0							37,200	38,100	37,300	38,300	40,100		12,900	18,700	19,100
Manganese		4,540.0	2,570	683	3,830	1,150	353	85	200	166	27	621	504	42	46	37	23
Mercury	0.0	2.9															
Nickel	96.0	150.0	150	25	40	20	22	2			5			8	2		
Potassium		54,900.0							5,510	5,740	14,200	17,300	16,900		14,300	17,300	17,700
Sodium		428,000.0							45,600	46,700	106,000	171,000	160,000		333,000	428,000	421,000
Vanadium		135.0	102	0	0	0	5	2			10			2	2		
Zinc	86.0	441.0	441	0	60	12	83	3			3			11	4		
Cyanide	5.2	23.5	0	0	0	0	24	5			5			5	5		

Notes
- All Results ug/l
- F - Filtered
- U - Unfiltered
- A - Unknown
- Round 1 - 5/23/86 (Phase I RI)
- Round 2 - 8/21/86 Phase I RI)
- Round 3 - 7/28/87 (Phase I RI)
- Round 4 - 5/7/90 Phase II RI)
- Round 5 - 10/10/94 (GWDI)
- For clarity, parameters not detected are not shown

Beryllium, Selenium, Silver, and Thallium not detected in any wells

Table 5 (cont.)

Skinner Landfill- Groundwater Remedial Design Investigation

Historical Metals Data

		Well	GW29	GW30	GW30	GW30	GW31	GW31	GW31	GW31	GW38	GW38	GW38
		Round	4	4	5	5	4	4	5	5	4	5	5
	Existing	Filtered	A	A	U	F	A	A	U	F	A	U	F
Compound	Trigger	Max											
Aluminum		55,600.0	7	7			7	7	1,540		7		
Antimony	30.0	64.8		20			26				30		
Arsenic	5.0	61.2	2	2			2	2			2		
Barium	1,000.0	5,950.0	26	792	332	336	368	373	572	534	615	771	719
Cadmium	1.1	2.5	1	1			1	1			1		
Calcium		269,000.0		61,200	63,300	63,700	89,200		114,000	10,600	53,000	74,000	77,000
Chromium	11.0	137.0	2	23			6	2			2		
Cobalt		94.0	2	2			2	2			2		
Copper	12.0	163.0	6	8			9	5			3		
Iron	1.0	19,100.0		235	360	437			2,810	100	493	1,580	1,490
Lead	3.2	94.0	34	28			6	5	3		14		
Magnesium		91,200.0		26,200	29,200	29,400	32,500		43,600	41,500	28,000	38,700	39,800
Manganese		4,540.0	16	34	56	57	54	50	309	241	36	67	90
Mercury	0.0	2.9											
Nickel	96.0	150.0	2	2			2	2			2		
Potassium		54,900.0		8,200	11,900	12,500	5,690		5,940	5,250	6,890	7,940	9,980
Sodium		428,000.0		79,300	136,000	136,000	41,000		53,100	50,700	116,000	155,000	207,000
Vanadium		135.0	2	2			2	2			2		
Zinc	86.0	441.0	26	20			9	2			3		
Cyanide	5.2	23.5	5	5			5	5			5		

Notes

All Results ug/l

F - Filtered

U - Unfiltered

A - Unknown

Round 1 - 5/23/86 (Phase I RI)

Round 2 - 8/21/86 Phase I RI)

Round 3 - 7/28/87 (Phase I RI)

Round 4 - 5/7/90 Phase II RI)

Round 5 - 10/10/94 (GWDI)

For clarity, parameters not detected are not shown

Beryllium, Selenium, Silver, and Thallium not detected in any wells

02/07/95

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Table 6

Skinner Landfill - Groundwater Remedial Design Investigation
Trigger Level Graphical Analysis Data Base

Well	Data Source	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
B-5	GWDI	190	19	14.9	55.1	1	1	234000	2.5	3	2.5	9780	1.5	50400	659
GW-06	GWDI														
GW-06	IRM 10/93	520	7.1	1.5	1460	0.7	1.7	48600	8.2	2	9.05	949	0.26	16500	308
GW-06	IRM 2/94	314	28	2.5	1080	0.5	2	49900	4.5	7	6	546	1.5	17200	399
GW-06	IRM 4/94	819	13	2.5	1220	0.5	2	62700	4.5	5.5	18.4	1540	11.9	17000	436
GW-06	IRM 7/93	55.1	7.5	1	990	0.5	2	37100	4	3	7.3	113	1.2	9420	183
GW-06	IRM 7/94														
GW-7R	GWDI														
GW-7R	IRM 7/94	873	15.5	2.5	398	2	1	169000	2	11.5	5	1830	1.5	38100	690
GW-09	GWDI	335	19	2.5	884	1	1	88400	2.5	3	2.5	2390	1.5	39500	35.4
GW-09	IRM 10/93	90.3	7.1	0.3	644	0.7	1.7	85800	1.5	2	9.05	1010	0.31	39100	31.6
GW-09	IRM 2/94	301	28	2.5	706	0.5	2	78200	4.5	7	6	1410	1.5	36800	28.4
GW-09	IRM 4/94	838	13	2.5	646	0.5	2	89900	4.5	5.5	10.8	3230	1.5	42300	70.4
GW-09	IRM 7/93	8	7.5	1	428	0.5	2	77700	4	3	4.4	96.8	1.4	37000	36.1
GW-09	IRM 7/94	42	15.5	2.5	656	2	1	89300	2	11.5	5	1060	1.5	40800	30
GW-10	GWDI	855	19	2.5	125	1	1	243000	8.8	3	12.8	2860	5.4	91200	591
GW-10	IRM 10/93	319	7.1	3.4	126	0.7	1.7	226000	5.6	2	9.05	3810	0.8	83900	744
GW-10	IRM 2/94	36	74.7	2.5	83.7	0.5	2	199000	4.5	7	6	15	1.5	73300	461
GW-10	IRM 4/94	96.5	13	2.5	109	0.5	2	224000	4.5	11.1	10.9	3420	1.5	90000	711
GW-10	IRM 7/93	148	7.5	16.2	186	0.5	4.8	223000	14.1	10.8	8.9	9430	3.8	81900	1080
GW-10	IRM 7/94	850	15.5	2.5	88.6	2	1	219000	7	11.5	17.1	1630	1.5	83100	1200
GW-10R	GWDI	741	19	2.5	110	1	1	239000	5.4	3	7.8	2140	3.9	89900	562
GW-11	GWDI	28.5	19	2.5	90.4	1	1	251000	2.5	3	2.5	472	1.5	81700	4430
GW-17	GWDI	28.5	19	20	210	1	1	116000	2.5	3	2.5	12000	1.5	38600	922

Notes:

All Results ug/l

Shaded Value = Detected Conc.

Blank Value = Not Analyzed

02/07/95

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Table 6 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Trigger Level Graphical Analysis Data Base

Well	Data Source	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
GW-18	GWDI	28.5	19	9.9	176	1	1	182000	2.5	3	2.5	1130	1.5	48600	646
GW-25	GWDI	1020	19	2.5	106	1	1	130000	2.5	3	2.5	1710	1.5	37200	200
GW-26	GWDI	106	19	2.5	366	1	1	74700	2.5	3	2.5	203	1.5	38300	621
GW-28	GWDI	714	19	2.5	93.9	1	1	42500	2.5	3	2.5	855	1.5	18700	36.6
GW-28	IRM 10/93	11200	7.1	0.3	114	0.7	1.7	46600	22.4	5.9	9.05	8690	1.9	19400	135
GW-28	IRM 2/94	815	28	2.5	97.8	0.5	2	45100	4.5	7	6	1410	1.5	19800	56.7
GW-28	IRM 4/94	1600	13	2.5	82	0.5	2	36700	4.5	11.1	2.5	2950	1.5	16400	55.2
GW-28	IRM 7/93	8	7.5	1	88.6	0.5	2	30000	4	3	4.1	21.1	1	15300	19
GW-28	IRM 7/94	4550	15.5	2.5	97.1	2	2.4	44700	6.3	11.5	16.1	6860	3.2	19700	125
GW-28R	GWDI	1450	19	2.5	95.4	1	1	42500	2.5	3	2.5	1410	3	18900	45.4
GW-30	GWDI	97	19	2.5	332	1	1	63300	2.5	3	2.5	360	1.5	29200	55.5
GW-31	GWDI	1540	19	2.5	572	1	1	114000	2.5	3	2.5	2810	3.3	43600	309
GW-38	GWDI	28.5	19	2.5	771	1	1	74000	2.5	3	2.5	1580	1.5	38700	66.5
GW-38	IRM 10/93	112	7.1	0.79	681	0.7	1.7	70600	1.5	2	9.05	1530	0.52	36300	72.4
GW-38	IRM 2/94	585	28	2.5	686	0.5	2	64300	4.5	7	6	1830	1.5	34600	72.8
GW-38	IRM 4/94	297	13	2.5	738	0.5	2	72700	4.5	5.5	2.5	2050	1.5	38900	104
GW-38	IRM 7/93	283	7.5	2.7	615	0.5	2	64400	4	3	3.2	1410	3	30400	103
GW-38	IRM 7/94	165	15.5	2.5	726	2	1	69100	2	11.5	5	1660	1.5	38500	89.2
GW-50	GWDI	17200	19	8.6	1060	1	1	440000	33.6	26.5	53	52900	45.9	105000	2580
GW-51	GWDI	967	19	18.1	444	1	1	391000	2.5	3	10.2	11000	6.6	125000	899
GW-52	GWDI	26200	19	16.8	770	1	1	513000	46.5	33.2	68.8	62900	41.1	110000	2930
GW-53	GWDI	5050	19	6.3	428	1	1	481000	13.4	7.4	11.2	22500	13.4	103000	2400
GW-53R	GWDI	9180	19	9.7	522	1	1	659000	21.5	12.3	29.7	38800	28	143000	3390
GW-56	GWDI	10900	19	2.5	126	1	1	388000	18.4	12.9	19.5	24000	12.2	107000	3290
GW-57	GWDI	13400	42.3	2.5	93.4	1	1	437000	26.4	15.4	25.1	32400	16.5	109000	1390

Notes:

All Results ug/l

Shaded Value = Detected Conc.

Blank Value = Not Analyzed

02/07/95

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Table 6 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Trigger Level Graphical Analysis Data Base

Well	Data Source	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Cyanide
B-5	GWDI	0.1	13	5740	2.5	2.5	43600	2.5	8.5	2.5	5
GW-06	GWDI										5
GW-06	IRM 10/93	0.1	10.4	19300	0.25	1	44100	0.25	1.5	34	2.5
GW-06	IRM 2/94	0.1	12	16400	2.5	3	33900	2.5	6	28.6	5
GW-06	IRM 4/94	0.1	11.5	16700	2.5	2.5	30100	2.5	10.2	32	5
GW-06	IRM 7/93	0.1	22.8	14500	0.5	2	24900	1	2	38.1	2.5
GW-06	IRM 7/94										5
GW-7R	GWDI										
GW-7R	IRM 7/94	0.22	19	3700	2.5	3.5	20000	2.5	11	6	5
GW-09	GWDI	0.1	13	3870	2.5	2.5	54100	2.5	8.5	2.5	5
GW-09	IRM 10/93	0.1	2.6	4380	0.25	1	49800	0.8	1.5	15.6	2.5
GW-09	IRM 2/94	0.1	12	3920	2.5	3	47400	2.5	6	23.3	5
GW-09	IRM 4/94	0.1	11.5	4480	2.5	2.5	52200	2.5	4.5	15.7	5
GW-09	IRM 7/93	0.1	16	6970	0.5	5.2	39800	1	2	2	
GW-09	IRM 7/94	0.1	19	5030	2.5	3.5	50100	2.5	11	6	5
GW-10	GWDI	0.1	13	54900	2.5	2.5	159000	2.5	8.5	8	10
GW-10	IRM 10/93	0.1	17.7	52900	0.81	1	148000	0.25	1.5	27.6	9.8
GW-10	IRM 2/94	0.1	12	41400	2.5	3	115000	2.5	6	18.8	5
GW-10	IRM 4/94	0.1	11.5	49900	2.5	2.5	159000	2.5	11.6	20.3	5
GW-10	IRM 7/93	0.1	28.5	56900	2.5	2	148000	1	2	26.3	6.6
GW-10	IRM 7/94	0.1	19	50500	2.5	3.5	171000	2.5	11	6	5
GW-10R	GWDI	0.1	13	54100	2.5	2.5	157000	2.5	8.5	2.5	10
GW-11	GWDI	0.1	33.8	39200	2.5	2.5	178000	2.5	8.5	2.5	5
GW-17	GWDI	0.1	13	35000	2.5	2.5	64200	2.5	8.5	2.5	10

Notes:

All Results ug/l

Shaded Value = Detected Conc.

Blank Value = Not Analyzed

Table 6 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation

Trigger Level Graphical Analysis Data Base

Well	Data Source	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Cyanide
GW-18	GWDI	0.1	13	35700	2.5	2.5	90100	2.5	8.5	7.2	5
GW-25	GWDI	0.1	13	5510	2.5	2.5	45600	2.5	8.5	2.5	5
GW-26	GWDI	0.1	13	17300	2.5	2.5	171000	2.5	8.5	2.5	5
GW-28	GWDI	0.1	13	17300	2.5	2.5	428000	2.5	8.5	2.5	5
GW-28	IRM 10/93	0.46	14.8	20900	0.25	1	358000	0.25	18.2	37.7	2.5
GW-28	IRM 2/94	0.1	12	15500	2.5	3	366000	2.5	6	28.1	5
GW-28	IRM 4/94	0.1	11.5	14300	2.5	2.5	324000	2.5	15.5	10.3	5
GW-28	IRM 7/93	0.1	3.5	15900	0.5	2	320000	3.6	2	2	2.5
GW-28	IRM 7/94	0.1	19	15900	2.5	3.5	359000	2.5	11	6	5
GW-28R	GWDI	0.1	13	17300	2.5	2.5	422000	2.5	8.5	2.5	5
GW-30	GWDI	0.1	13	11900	2.5	2.5	136000	2.5	8.5	2.5	5
GW-31	GWDI	0.1	13	5940	2.5	2.5	53100	2.5	8.5	2.5	5
GW-38	GWDI	0.1	13	7940	2.5	2.5	155000	2.5	8.5	2.5	5
GW-38	IRM 10/93	0.1	2.6	8170	0.25	1	150000	0.5	1.5	11.9	2.5
GW-38	IRM 2/94	0.1	12	7310	2.5	3	129000	2.5	6	14.1	5
GW-38	IRM 4/94	0.1	11.5	8020	2.5	2.5	164000	2.5	4.5	3	5
GW-38	IRM 7/93	0.1	3.5	13400	0.5	2	126000	1	2	2	2.5
GW-38	IRM 7/94	0.1	19	7280	2.5	3.5	140000	2.5	11	6	5
GW-50	GWDI	0.1	64.9	10200	2.5	2.5	69500	2.5	53.2	155	5
GW-51	GWDI	0.1	13	15900	2.5	2.5	56800	2.5	8.5	12	5
GW-52	GWDI	0.1	65	28300	25	2.5	35300	2.5	62.6	212	5
GW-53	GWDI	0.1	34.4	20000	25	29.1	35700	25	19	57	5
GW-53R	GWDI	0.1	40.9	20300	25	36.1	36500	25	35	95.8	5
GW-56	GWDI	0.1	34.4	29500	2.5	2.5	142000	2.5	29.6	66.5	5
GW-57	GWDI	0.1	34.5	12000	2.5	2.5	92900	2.5	37.3	83.8	5

Notes:

All Results ug/l

Shaded Value = Detected Conc.

Blank Value = Not Analyzed

TABLE 7

SKINNER LANDFILL GROUNDWATER REMEDIAL DESIGN INVESTIGATION
SELECTION CRITERIA FOR GRAPHICAL ANALYSIS

Element	# of Times Element Detected	# of Times Element not Detected	Ratio of Detection vs. non detection	Trigger Level set	Graphical Analysis Conducted
Aluminum	35	46	.76	No	No
Antimony	1	46	.02	Yes	No
Arsenic	9	46	.20	**Yes**	Yes
Barium	35	46	.76	Yes	Yes
Beryllium	0	46	.00	Yes	No
Cadmium	5	46	.11	**Yes**	Yes
Calcium	46	46	1.00	No	No
Chromium	12	46	.26	Yes	Yes
Cobalt	4	46	.09	No	No
Copper	14	46	.30	Yes	Yes
Iron	44	46	.96	Yes	Yes
Lead	23	46	.50	Yes	Yes
Magnesium	46	46	1.00	No	No
Manganese	46	46	1.00	No	No
Mercury	2	46	.04	Yes	No
Nickel	8	46	.17	Yes	Yes
Potassium	44	46	.96	No	No
Selenium	1	46	.02	Yes	No

TABLE 7 (CONT.)

Element	# of Times Element Detected	# of Times Element not Detected	Ratio of Detection vs. non detection	Trigger Level set	Graphical Analysis Conducted
Silver	2	46	.04	Yes	No
Sodium	46	46	100	No	No
Thallium	3	46	.07	Yes	Yes
Vanadium	5	46	.11	No	No
Zinc	21	46	.46	Yes	Yes
Cyanide	6	48	.13	Yes	Yes

[1]Page 1, Graphsta.WP

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Table 8

Skinner Landfill - Groundwater Remedial Design Investigation
Development of Modified Trigger Level

VOLATILE ORGANIC COMPOUNDS

CAS No	Compound	units	Existing Trigger	CRDL	Statistical Limit	Modified Trigger Limit
71-55-6	1,1,1-Trichloroethane	ug/l	88	1		88
79-34-5	1,1,2,2-Tetrachloroethane	ug/l	107	1		107
79-00-5	1,1,2-Trichloroethane	ug/l	418	1		418
107-06-2	1,2-Dichloroethane	ug/l	5	1		5
540-59-0	1,2-Dichloroethene (total)**	ug/l	70	1		70
78-87-5	1,2-Dichloropropane	ug/l	5	1		5
78-93-3	2-Butanone	ug/l	7.1	1		7.1
71-43-2	Benzene	ug/l	5	1		5
56-23-5	Carbon Tetrachloride	ug/l	5	1		5
108-90-7	Chlorobenzene	ug/l	26	1		26
67-66-3	Chloroform	ug/l	79	1		79
100-41-4	Ethylbenzene	ug/l	62	1		62
100-42-5	Styrene	ug/l	56	1		56
127-18-4	Tetrachloroethene	ug/l	5	1		5
108-88-3	Toluene	ug/l	1000	1		1000
79-1-6	Trichloroethene	ug/l	5	1		5
75-01-4	Vinyl Chloride	ug/l	2	1		2
1330-20-7	Xylene (total)	ug/l	10000	1		10000

SEMI-VOLATILE ORGANICS

CAS No	Compound	units	Existing Trigger	CRDL	Statistical Limit	Modified Trigger Limit
120-82-1	1,2,4-Trichlorobenzene	ug/l	77	10		77
95-50-1	1,2-Dichlorobenzene	ug/l	11	10		11
541-73-1	1,3-Dichlorobenzene	ug/l	600	10		600
106-46-7	1,4-Dichlorobenzene	ug/l	75	10		75
108-60-1	2,2'-oxybis-(1-Chloropropane)#	ug/l	4360	10		4360
105-67-9	2,4-Dimethylphenol	ug/l	2120	10		2120
100-02-7	4-Nitrophenol	ug/l	150	50		150
83-32-9	Acenaphthene	ug/l	520	10		520
56-55-3	Benzo(a)anthracene	ug/l	0.1	10		10
50-32-8	Benzo(a)pyrene	ug/l	0.2	10		10
205-99-2	Benzo(b)fluoranthene	ug/l	0.2	10		10
191-24-2	Benzo(g,h,i)perylene	ug/l	3.1	10		10
207-08-9	Benzo(k)fluoranthene	ug/l	0.2	10		10
111-44-4	bis(2-Chloroethyl)Ether	ug/l	13.6	10		13.6
117-81-7	bis(2-Ethylhexyl)phthalate	ug/l	49	10		49
85-68-7	Butylbenzylphthalate	ug/l	8.4	10		10
218-01-9	Chrysene	ug/l	3.1	10		10
84-74-2	Di-n-butylphthalate	ug/l	190	10		190
53-70-3	Dibenzo(a,h)anthracene	ug/l	3.1	10		10
131-11-3	Dimethylphthalate	ug/l	73	10		73
206-44-0	Fluoranthene	ug/l	8.9	10		10
67-72-1	Hexachloroethane	ug/l	0.99	10		10
193-39-5	Indeno(1,2,3-cd)pyrene	ug/l	3.1	10		10
78-59-1	Isophorone	ug/l	900	10		900
91-20-3	Naphthalene	ug/l	44	10		44
98-95-3	Nitrobenzene	ug/l	27000	10		27000
85-01-8	Phenanthrene	ug/l	6.3	10		10
108-95-2	Phenol	ug/l	370	10		370

Notes: All results in ug/l.

Only parameters with existing Table 1 trigger levels were evaluated.

- Previously known by the name bis(2-Chloroisopropyl)ether

** Existing trigger for cis isomer is 70 ug/l, trans isomer is 100 ug/l, CRDL for total 1,2 dichloroethene only

Table 8 (cont.)

Skinner Landfill - Groundwater Remedial Design Investigation
Development of Modified Trigger Level

INORGANICS			Existing		Statistical	Modified
CAS No	Compound	units	Trigger	CRDL	Limit	Trigger Limit
7440-36-0	Antimony	ug/l	30	60	--	60
7440-38-2	Arsenic	ug/l	5	10	4.3	10
7440-39-3	Barium	ug/l	1000	200	235	1000
7440-41-7	Beryllium	ug/l	4	5	--	5
7440-43-9	Cadmium	ug/l	1.1	5	2.35	5
7440-47-3	Chromium	ug/l	11	10	7.6	11
7440-50-8	Copper	ug/l	12	25	13	25
7439-89-6	Iron	ug/l	1	100	5000	5000
7439-92-1	Lead	ug/l	3.2	3	4.2	4.2
7439-97-6	Mercury	ug/l	0.012	0.2	--	0.2
7440-02-0	Nickel	ug/l	96	40	22.5	96
7782-49-2	Selenium	ug/l	5	5	--	5
7440-22-4	Silver	ug/l	0.12	10	--	10
7440-28-0	Thallium	ug/l	40	10	4.2	40
7440-66-6	Zinc	ug/l	86	20	15	86
5955-70-0	Cyanide	ug/l	5.2	10	7.25	10

Notes: All results in ug/l.

Only parameters with existing Table 1 trigger levels were evaluated.

May 25, 1995
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Table 9

Skinner Landfill - Groundwater Remedial Design Investigation
Development of Effluent Limits

Volatile Organic Compounds
All the following Volatile Organic Compounds regulated at 5 ug/l monthly average, 10 ug/l daily maximum:

1.	Benzene	22.	Dibromomethane	43.	Pentachloroethane
2.	Bromobenzene	23.	1,2-Dibromomethane	44.	N-Propylbenzene
3.	Bromochloromethane	24.	1,2-Dichlorobenzene	45.	Styrene
4.	Bromodichloromethane	25.	1,3-Dichlorobenzene	46.	1,1,1,2-Tetrachloroethane
5.	Bromoform	26.	1,4-Dichlorobenzene	47.	1,1,2,2-Tetrachloroethane
6.	Bromomethane	27.	Dichlorodifluoromethane	48.	Tetrachloroethene
7.	2-Butanone (MEK)	28.	1,1-Dichloroethane	49.	Toluene
8.	N-butylbenzene	29.	1,2-Dichloroethane	50.	1,2,3-Trichlorobenzene
9.	Sec-Butylbenzene	30.	1,1-Dichloroethene	51.	1,2,4-Trichlorobenzene
10.	Tert-Butylbenzene	31.	trans-1,2-Dichloroethene	52.	1,1,1-Trichloroethane
11.	Carbon Disulfide	32.	cis-1,2-Dichloroethene	53.	1,1,2-Trichloroethane
12.	Carbon Tetrachloride	33.	1,2-Dichloropropane	54.	Trichloroethene
13.	Chlorobenzene	34.	2,2-Dichloropropane	55.	Trichlorofluoromethane
14.	Chloroethane	35.	1,3-Dichloropropane	56.	1,2,3-Trichloropropane
15.	Chloroform	36.	1,1-Dichloropropene	57.	1,2,4-Trimethylbenzene
16.	Bis-2-chloroisopropylether	37.	Isopropylbenzene	58.	1,3,5-Trimethylbenzene
17.	Chloromethane	38.	Ethyl Benzene	59.	Vinyl Acetate
18.	o-Chlorotoluene	39.	Hexachloro-1,3-butadiene	60.	Vinyl Chloride
19.	P-Chlorotoluene	40.	2-Hexanone	61.	O-xylene
20.	Dibromomethane	41.	p-Isopropyltoluene	62.	m-xylene
21.	1,2-dibromo-3-chloropropane	42.	Methylene Chloride	63.	p-xylene

Semi-Volatile Organics

Cas No.	Compound	Units	MDL	Water Quality Standards Ave	Water Quality Standards Max	Proposed Limit Ave	Proposed Limit Max
111-44-4	Bis(2-chloroethyl)ether	ug/l	10	13.6	---	13.6	---
117-81-7	Bis(2-ethylhexyl)phthalate	ug/l	10	8.4	1100	10	1100
91-20-3	Naphthalene	ug/l	10	44	160	44	160
108-95-2	Phenol	ug/l	10	370	5300	370	5300

Table 9 (cont.)

Inorganics

Cas No.	Compound	Units	MDL	Water Quality Standards		Proposed Limit	
				Ave	Max	Ave	Max
7440-36-0	Antimony	ug/l	60	190	650	190	650
7440-38-2	Arsenic	ug/l	10	100	360	100	360
7440-43-9	Cadmium	ug/l	5	4.9	32	5	32
7440-47-3	Chromium	ug/l	5	100	6700	100	6700
7440-50-8	Copper	ug/l	10	52	90	52	90
5955-70-0	Cyanide	ug/l	10	12	46	12	46
7439-92-1	Lead	ug/l	3	54	1000	54	1000
7439-97-6	Mercury	ug/l	0.2	0.012	1.1	0.2	1.1
7440-02-0	Nickel	ug/l	40	200	6300	200	6300
7782-49-2	Selenium	ug/l	5	5	20	5	20
7440-22-4	Silver	ug/l	10	1.3	25	10	25
7440-28-0	Thallium	ug/l	10	16	71	16	71
7440-66-6	Zinc	ug/l	20	410	450	410	450

Other

Parameter	Units	Water Quality Standards		Proposed Limit	
		Ave	Max	Ave	Max
Dissolved Solids	mg/l	1500	----	1500	---
PAHs	ug/l	0.31	---	0.31	---

Table 10
Skinner Landfill - Groundwater Remedial Design Investigation
Historical Groundwater Elevations

All elevations are reported in Feet above Mean Sea Level (MSL)

Well	Reference (From Boring Logs)	Remedial Design Investigation 01/19/95	Phase II Remedial Investigation 02/07/91	07/19/90	05/15/90	05/06/90	04/20/90	04/18/90	04/17/90	Phase I Interim Remedial Investigation 05/13/86 to 05/23/86	08/19/86 to 08/21/86
GW6	687.96	672.13	683.87		652.23	675.41	676.29				670.37
GW7,GW7R	687.63, 684.10	GW7R 679.61		678.61	682.35		678.98			678.93	678.69
GW08	689.22									671.88	670.88
GW9	693.24	669.02	669.66	669.16	669.21	669.26				668.82	668.24
GW10	691.43	688.06		687.56	687.8	688.2				687.15	687.85
GW11	706.19	697.41	701.1	698.15	699.94	700.2				698.8	697.11
GW12	704.08	not found		697.29	698.44	698.72				698.28	696.85
GW13	758.9									704.52	DRY
GW14	746.92		734.22	732.85	734.36	735.66				733.05	731.15
GW15	729.65	lock broken	722.32	717.1	721.4	723.33				718.72	717.65
GW16	703.56									690.34	687.16
GW17	750.83	728.19	727.32	723.95	726.46	726.7	725.38		725.57	725.38	722.93
GW18	750.59	722.61	730.12	724.45	729.56	729.67	728.2		728.43	728.63	723.57
GW19	734.37		712.74	710.38	714.21	713.01				712.95	703.37
GW20	738.03		697.04	697.16	696.43	696.29				697.33	697.22
GW21	735.43									712.79	
GW22	750.4									742.23	738.11
GW23	769.84		766.22	759.77	765.37	765.66				762.95	759.8
GW24	696.12	dry	680.28	678.03	679.24	679.78	678.55	678.56	678.6		
GW25	696.36	678.74	dry	4" in screen	dry	dry	dry				
GW26	699.27	668.78	670.14	669.39	669.93	670	669.71	669.73	669.78		
GW27	736.73		670	669.23	669.82	669.76	669.58	669.25	669.59		
GW28	688.25	672.6	673.5	672.18	672.67	672.63	672.3	672.35			
GW29	722.11		696.17	694.69	696.07	696.11	695.59	696.75			
GW30	678.62	668.23	668.61	668.16	667.93	667.96	667.67	667.47	667.67		
GW31	677.59	666.54	667.06	666.48	666.1	666.02	665.91				
GW32	673.02		667.84	666.89	667.56	667.51	667.44	667.43	667.48		
GW33	672.74		668.12	667.55	668.01	668.06	667.91				
GW35	671.98		667.86	667.33	667.58	667.54	667.53	667.53	667.59		
GW36	671.84		667.37	666.56	667.13	667.2	667				
GW38	684.50	668.59	669.61	668.93	668.91		668.75	668.72	668.81		
B005	**731.09	718.42	721.27	719.35	722.73	719.63					
B008	**732.35	717.98	720.57	720.02	721.47	722.99					
GW50	684.16	668.81									
GW51	747.19	690.69									
GW52	688.84	675.76									
GW53	687.99	682.02									
GW54	692.10	670.34									
GW55	700.98	688.02									
GW56	702.36	696.66									
GW57	707.29	699.45									

** From Phase II Remedial Investigation Report

Table 11

Skinner Landfill - Groundwater Remedial Design Investigation
Groundwater Flow into Trench

Station	Unit length of Trench X (ft)	GW Well Zone	Hydraulic Conductivity K (gpd/sf)	Influenced Thickness H (ft)	Iteration #1 Initial: Length of Influence L (ft)	Iteration #1 Initial: Collected Flow Q (gpm)	Iteration #2 Mid-term: L (ft)	Iteration #2 Mid-term: Q (gpm)	Iteration #3 Long term: L (ft)	Iteration #3 Long term: Q (gpm)	Iteration #4 Long term: L (ft)	Iteration #4 Long term: Q (gpm)
0+50	100	GW50	0.31	10	5	0.22	15	0.07	25	0.04	100	0.01
1+50	100	GW50	0.31	22	5	1.04	15	0.35	25	0.21	100	0.05
2+50	100	GW52*	0.31	16	5	0.55	15	0.18	25	0.11	100	0.03
3+50	50	GW52	0.03	21	5	0.05	15	0.02	25	0.01	100	0.00
4+50	No Collection Trench from Station 3+00 to Station 6+50											
5+50	Add 50 ft. on either side to be conservative											
6+50	100	GW53	1.19	10	5	0.83	15	0.28	25	0.17	100	0.04
7+50	100	GW54*	1.19	15	5	1.86	15	0.62	25	0.37	100	0.09
8+50	100	GW54*	1.19	10	5	0.83	15	0.28	25	0.17	100	0.04
9+50	100	GW54*	1.19	7	5	0.40	15	0.13	25	0.08	100	0.02
10+50^	100	GW56*	1.19	5	5	0.41	15	0.14	25	0.08	100	0.02
11+50^	100	GW56	3.43	2	5	0.19	15	0.06	25	0.04	100	0.01
12+50^	100	GW57*	3.43	5	5	1.19	15	0.40	25	0.24	100	0.06
13+50^	100	GW57	1.19	4	5	0.26	15	0.09	25	0.05	100	0.01
					Total (gpm)	7.8	gpm	2.6	gpm	1.6	gpm	0.4
					Total (gpd)	11,276	gpd	3,759	gpd	2,255	gpd	564

Flow Projection by Monitoring Well Zone (gpd)	Iteration #1	Iteration #2	Iteration #3	Iteration #4
GW50	1,810	603	362	91
GW52	860	287	172	43
GW53	1,190	397	238	60
GW54	4,451	1,484	890	223
GW56	869	290	174	43
GW57	2,096	699	419	105

Notes:

Values K, & H selected per 100 ft stationing using closest well K value and measured H

* Flow calculations used higher value from adjacent well for more conservative approach

^ Trench flow is from two(both) sides, therefore flow quantity was doubled

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Table 12

Skinner Landfill - Groundwater Remedial Design Investigation
Trench Line Wells, Organic "Hits"

				Revised	SAMPLE GW50	SAMPLE GW51*	SAMPLE GW52	SAMPLE GW53	SAMPLE GW54	SAMPLE GW55	SAMPLE GW56	SAMPLE GW57
CAS No	Compound	CRDL	Maximum	Trigger	10/10/94	10/10/94	10/10/94	10/10/94	10/10/94	10/10/94	10/10/94	10/10/94
75-34-3	1,1-Dichloroethane	10	2(J)			1(J)		2(J)				
540-59-0	1,2-Dichloroethene(total)	10	5	70		5		1(J)				
108-10-1	4-Methyl-2-Pentanone	10	1(J)						1(J)			
67-64-1	Acetone	10	17		8(J)		10		17	6(J)		
71-43-2	Benzene	10	220	5		220		20				
108-90-7	Chlorobenzene	10	2(J)	26		2(J)						
75-0-3	Chloroethane	10	25			25		6(J)				
100-41-4	Ethylbenzene	10	11	62		11						
75-09-2	Methylene Chloride	10	3(J)		2(J)	3(J)	3(J)	3(J)	3(J)	3(J)	2(J)	2(J)
108-88-3	Toluene	10	4(J)	1000		4(J)						
79-01-6	Trichloroethene	10	1(J)	5		1(J)						
1330-20-7	Xylene	10	8(J)	10000	3(J)	8(J)	3(J)	3(J)	3(J)	3(J)	3(J)	3(J)
111-44-4	bis(2-Chloroethyl)Ether	10	41	13.6		41		40				
117-81-7	bis(2ehtylhexyl) phthalate	10	1(J)	49		1(J)						
108-60-1	2,2-'oxybis(1-chloropropane)	10	2(J)	4360								2(J)

Notes:

All Results in ug/l

* Well GW51 is not physically on Trench line

For clarity, parameters not detected are not shown.

(J) designation indicates parameter detected below CRDL.

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Table 13

Skinner Landfill - Groundwater Remedial Design Investigation
Trench Line Well Inorganic Data

			SAMPLE NO.		SAMPLE NO.		SAMPLE NO.		SAMPLE NO.		SAMPLE NO.		SAMPLE NO.		SAMPLE NO.		SAMPLE NO.	
		Revised	GW50		GW51*		GW52		GW53		GW56		GW57		SKFB		SKFD	
Compound	Maximum	Trigger	CONC	Note	CONC	Note	CONC	Note	CONC	Note	CONC	Note	CONC	Note	CONC	Note	CONC	Note
Aluminum	26200		17200		967		26200		5050		10900		13400				9180	
Antimony	42.3	60											42.3	B				
Arsenic	18.1	10	8.6	B	18.1		16.8		6.3	B							9.7	B
Barium	1060	1000	1060		444		770		428		126	B	93.4	B			522	
Calcium	659000		440000		391000		513000		481000		388000		437000				659000	
Chromium	46.5	11	33.6				46.5		13.4		18.4		26.4				21.5	
Cobalt	33.2		26.5	B			33.2	B	7.4	B	12.9	B	15.4	B			12.3	B
Copper	68.8	25	53		10.2	B	68.8		11.2	B	19.5	B	25.1				29.7	
Iron	62900	5000	52900		11000		62900		22500		24000		32400				38800	
Lead	45.9	4.2	45.9		6.6		41.1		13.4		12.2		16.5				28	
Magnesium	143000		105000		125000		110000		103000		107000		109000				143000	
Manganese	3390		2580		899		2930		2400		3290		1390				3390	
Nickel	65	96	64.9				65		34.4	B	34.4	B	34.5	B			40.9	
Potassium	29500		10200		15900		28300		20000		29500		12000				20300	
Silver	36.1	10							29.1								36.1	
Sodium	142000		69500		56800		35300		35700		142000		92900				36500	
Vanadium	62.6		53.2				62.6		19	B	29.6	B	37.3	B			35	B
Zinc	212	86	155		12	B	212		57		66.5		83.8				95.8	

Note: All Results in ug/l

"'B" designation indicates reading less than CRDL

* Well GW51 is not physically on Trench Line

Wells GW54 and GW55 did not provide enough sample for inorganic analysis

Beryllium, cadmium, cyanide, selenium, and thallium wer not detected in any wells

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Table 14

Skinner Landfill - Groundwater Remedial Design Investigation
Surface Water "Hits"

Volatile Organics

CAS No	Compound	Maximum	Revised Trigger	SAMPLE SKSW50 CONC	Note	SAMPLE SKSW51* CONC	Note	SAMPLE SKSW52 CONC	Note	SAMPLE SKSW53 CONC	Note
67-64-1	Acetone	12						12			
75-09-2	Methylene Chloride	28		26	B	26	B			28	B

Semi-Volatile Organics

CAS No	Compound	Maximum	Revised Trigger	SAMPLE SKSW50 CONC	Note	SAMPLE SKSW51* CONC	Note	SAMPLE SKSW52 CONC	Note	SAMPLE SKSW53 CONC	Note
	No compound detected										

Inorganics

CAS No	Compound	Maximum	Revised Trigger	SAMPLE SKSW50 CONC	Note	SAMPLE SKSW51* CONC	Note	SAMPLE SKSW52 CONC	Note	SAMPLE SKSW53 CONC	Note
7429-90-5	Aluminum	104		104	B			64.7	B		
7440-36-0	Antimony	48.2	60					38	J	48.2	B
7440-39-3	Barium	115	1000	89.8	B	109	B	78.6	B	115	B
7440-43-9	Cadmium		5								
7440-70-2	Calcium	174000		137000		174000		126000		170000	
5955-70-0	Cyanide	57.6	10			57.6					
7439-89-6	Iron	373	5000	141				121		373	
7439-95-4	Magnesium	61200		49200		57300		47400		61200	
7439-96-5	Manganese	3910		79.5		31.2		56.8		3910	
7440-09-7	Potassium	10400		9410		10400		7980		7780	
23-5	Sodium	59500		51100		59500		50100		32800	
56-6	Zinc	23.9	86							23.9	

Notes: All results ug/l
"B" designation indicates analyte found below CRDL
signation indicates estimated value
clarity, parameters that were not detected are not shown
* Well GW51 is not physically on Trench Line

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Table 15

Skinner Landfill - Groundwater Remedial Design Investigation
Field Data - Trench Line Wells

Well	Sampling Event	Temp, C	Cond mu/cm	pH su	Turbidity ntu	Remarks
GW-50		13.6	0.741	7.37	>200	
		13.0	0.775	7.56		
GW-51		13.0	2.500	6.98	>200	
		10.8	2.430	7.05	>200	
GW-52		12.8	0.720	7.82		
		10.4	0.595	9.26	>200	
GW-53		13.6	2.000	6.98	>200	
		12.5	2.180	6.94	>200	
GW-54		14.1	1.118	7.38		
		9.3	1.478	7.50	>200	
GW-55		14.2	2.460	7.22	>200	
		11.5	2.260	7.18		
GW-56		15.2	2.060	6.87	>200	
		11.5	2.310	6.93	>200	
GW-57		13.7	1.763	7.14	>200	OLIVE TAN GRAY
		12.8	1.794	6.88	>200	

Note: Bailers used on all wells EXCEPT GW-51 (Keck Pump)
NTU's < 50 obtained on BW51 dated 11-11-94

Table 16

Skinner Landfill - Groundwater Remedial Design Investigation
Design Parameters Data

Well No.	TOX mg/l	TOC mg/l	COD mg/l	Sulfide mg/l	TDS mg/l	TKN mg/l	BOD mg/l
GW50	<0.5	3.4	44	0.2U	652	2.3	3U
GW51	<0.5	29.8	313	0.2U	2340	2.8	3U
GW53*	2.1	16.9	141	0.2U	2110	2.5	3U
GW54				0.2U			7
GW56	<0.5	33.1	196	0.2U	2100	23.6	3U
GW57	<0.5	27.2	264	0.2U	874	1.8	4

Notes:
"U" designation indicated the parameter was not detected
"<" designation indicates parameter was below CRDL
Not enough sample in Well GW54 to complete all analyses
TOX - Total Organic Halides
TOX - Total Organic Carbon
COD - Chemical Oxygen Demand
TDS - Total Dissolved Solids
TKN - Total Kjeldahl Nitrogen
BOD - Biochemical Oxygen Demand

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Table 17

Skinner Landfill - Groundwater Remedial Design Investigation
Organic Loading and Composite Concentration

CAS No	Compound	Proposed Limit	Composite Concentration ug/l	Total Loading lb/d
107-06-2	1,2-Dichloroethene	5	0.11	0.00001
71-43-2	Benzene	5	2.11	0.00020
100-41-4	Ethylbenzene	5	0.00	0.00000
79-01-6	Trichloroethene	5	0.00	0.00000
111-44-4	bis(2-Chloroethyl)Ether	13.6	4.22	0.00040
117-81-7	bis(2-Ethylhexyl)phthalate	10	0.00	0.00000

			SAMPLE GW50		SAMPLE GW51*		SAMPLE GW52		SAMPLE GW53	
		Proposed	Flow, gpd	1,810	Flow, gpd	0	Flow, gpd	860	Flow, gpd	1,190
CAS No	Compound	Limit	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d
107-06-2	1,2-Dichloroethene	5		0	5	0		0	1	0.00001
71-43-2	Benzene	5		0	220	0		0	20	0.00020
100-41-4	Ethylbenzene	5		0	11	0		0		0.00000
79-01-6	Trichloroethene	5		0	1	0		0		0.00000
111-44-4	bis(2-Chloroethyl)Ether	13.6		0	41	0		0	40	0.00040
117-81-7	bis(2-Ethylhexyl)phthalate	10		0	1	0		0		0.00000

			SAMPLE GW54		SAMPLE GW55		SAMPLE GW56		SAMPLE GW57	
		Proposed	Flow, gpd	4,451	Flow, gpd	0	Flow, gpd	869	Flow, gpd	2,096
C No	Compound	Limit	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d	Conc, ug/l	Load, lb/d
-2	1,2-Dichloroethene	5		0		0		0		0
71-43-2	Benzene	5		0		0		0		0
-41-4	Ethylbenzene	5		0		0		0		0
1-6	Trichloroethene	5		0		0		0		0
111-44-4	bis(2-Chloroethyl)Ether	13.6		0		0		0		0
117-81-7	bis(2-Ethylhexyl)phthalate	10		0		0		0		0

Composite Flowrate, gpd 11,276

Notes:
- All results in ug/l.
- Parameters not detected were not calculated.
- Values detected but below CRDL were calculated, except for xylene
- Parameters detected but without trigger levels were not calculated
- Wells GW50, GW52, GW53, GW54, GW55, GW56, and GW57 had no parameters Detected above CRDL

* Well GW51 is not physically on Trench Line

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Table 18

Skinner Landfill - Groundwater Remedial Design Investigation
Inorganic Loading and Composite Concentration

	Proposed	Composite	Total	SAMPLE	GW50	SAMPLE	GW51*	SAMPLE	GW52	SAMPLE	GW53	SAMPLE	GW54	SAMPLE	GW56	SAMPLE	GW57
		Conc.	Loading	Flow, gpd	1,810	Flow, gpd	0	Flow, gpd	860	Flow, gpd	1,190	Flow, gpd	4,451	Flow, gpd	869	Flow, gpd	2,096
Compound	Limit	ug/l	lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d	Conc. ug/l	Load, lb/d
Aluminum		8,623	0.811	17200	0.260	967	0	26200	0.188	5050	0.050		0	10900	0.079	13400	0.234
Antimony	190	8	0.001		0.000		0		0.000		0.000		0		0.000	42.3	0.001
Arsenic	100	3	0.000	8.6	0.000	18.1	0	16.8	0.000	6.3	0.000		0		0.000		0.000
Barium		301	0.028	1060	0.016	444	0	770	0.006	428	0.004		0	126	0.001	93.4	0.002
Beryllium		0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
Cadmium	5	0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
Calcium		271,647	25.546	440000	6.642	391000	0	513000	3.679	481000	4.774		0	388000	2.812	437000	7.639
Chromium	100	17	0.002	33.6	0.001		0	46.5	0.000	13.4	0.000		0	18.4	0.000	26.4	0.000
Cobalt		11	0.001	26.5	0.000		0	33.2	0.000		0.000		0	12.9	0.000	15.4	0.000
Copper	52	20	0.002	53	0.001	10.2	0	68.8	0.000		0.000		0	19.5	0.000	25.1	0.000
Iron		23,535	2.213	52900	0.799	11000	0	62900	0.451	22500	0.223		0	24000	0.174	32400	0.566
Lead	54	16	0.001	45.9	0.001	6.6	0	41.1	0.000	13.4	0.000		0	12.2	0.000	16.5	0.000
Magnesium		64,621	6.077	105000	1.585	125000	0	110000	0.789	103000	1.022		0	107000	0.775	109000	1.905
Manganese		1,403	0.132	2580	0.039	899	0	2930	0.021	2400	0.024		0	3290	0.024	1390	0.024
Mercury	0.200	0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
Nickel	200	28	0.003	64.9	0.001		0	65	0.000	34.4	0.000		0	34.4	0.000	34.5	0.001
Potassium		10,410	0.979	10200	0.154	15900	0	28300	0.203	20000	0.198		0	29500	0.214	12000	0.210
Selenium	5	0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
Silver	10	3	0.000		0.000		0		0.000	29.1	0.000		0		0.000		0.000
Sodium		45,828	4.310	69500	1.049	56800	0	35300	0.253	35700	0.354		0	142000	1.029	92900	1.624
Thallium	16	0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
Vanadium		25	0.002	53.2	0.001		0	62.6	0.000	19	0.000		0	29.6	0.000	37.3	0.001
Zinc	410	68	0.006	155	0.002	12	0	212	0.002	57	0.001		0	66.5	0.000	83.8	0.001
Cyanide	10	0	0.000		0.000		0		0.000		0.000		0		0.000		0.000
TDS	1,500,000	651,634	61.281	652,000	9.842	2,340,000	0		0.000	2,110,000	20.941		0	2,100,000	15.220	874,000	15.278

Composite Flowrate, gpd 11,276

Note: All results ug/l
For clarity, parameters not detected are not shown
lb/d = ug/l / 1000 x 8.34 x flow(gpd) / 1,000,000
Comp conc (ug/l) = lb/d / 8.34. / comp flow x 1,000,000 x 1000

* Well GW51 is not physically on Trench Line

APPENDIX I

RUST ENVIRONMENT & INFRASTRUCTURE

MEMORANDUM

Cincinnati Division

Date:	December 28, 1994
To:	Bruce Sypniewski, USEPA
cc:	Greg Youngstrom, OEPA Larry Bone, Skinner Landfill PRP Group
From:	Kent Heaton, RUST E&I Inc., Cincinnati, Ohio Jim Veith, RUST E&I Inc., Cincinnati, Ohio
Project:	Skinner Landfill West Chester, Butler County, Ohio
Subject:	Technical Memorandum 2 Groundwater Design Investigation Well Integrity Evaluation

1.0 INTRODUCTION

This technical memorandum presents the results of the well integrity evaluation conducted by RUST E & I for twenty (20) selected monitor wells at the Skinner Landfill. As stated in the Field Sampling Plan (FSP), Section 2.3.1, these wells include GW-06, GW-07R, GW-09, GW-10, GW-11, GW-12, GW-17, GW-18, GW-19, GW-20, GW-24, GW-25, GW-26, GW-27, GW-28, GW-30, GW-31, GW-38, B-5, and B-8. The locations of the wells are shown on Figure 2 of the Remedial Design FSP. The evaluation was conducted to determine the condition of the wells before confirmation sampling and evaluation of previous groundwater analytical results.

RUST personnel evaluated the integrity of the selected wells by visiting each location and recording observations including the location and label, the condition of the protective casing, the condition of the well casing, and the integrity of the lock.

2.0 RESULTS

The following wells were found to be in good condition, i.e., properly labelled and padlocked, with intact casing and secure base, and no evidence of silting.

GW-07R	GW-09	GW-10
GW-17	GW-18	GW-24
GW-25	GW-26	GW-27
GW-30	GW-31	

11785 Highway Drive, Suite 100, Cincinnati, Ohio, 45241, Phone: 513-733-9374, Fax: 513-733-8213

Minor deficiencies were found with the following wells:

GW-06	Protective casing allows rainwater to collect between the well casing and the protective casing.
GW-11	Concrete base is intact but loose at the base of the protective casing.
GW-19	Protective casing is secure but allows rainwater to collect between the well casing and the protective casing.
GW-28	Well casing is intact but cap is missing.
GW-38	Well casing cap is intact but does not fit snugly.
B-5	Outer protective casing is bent and allows rainwater to collect between the well casing and the protective casing.
B-8	Protective casing cap is broken.

Monitor well GW-12 could not be located by RUST personnel or the contract surveyor. This well may have been abandoned or destroyed.

The well casing of GW-20 is bent approximately 1.5 ft from its top and will not allow sampling. The outer protective casing is broken and allows rainwater to collect between the inner well casing and the outer protective casing.

3.0 RECOMMENDATIONS

For the wells having minor deficiencies as noted above, the following corrective measures are recommended. In addition, weep holes should be drilled at the base of all protective casings to prevent accumulation of rainwater between the well casing and the protective casing.

GW-06	Replace/repair outer protective casing.
GW-11	Secure the concrete base by excavating around base and adding additional concrete.

GW-19	Replace/repair outer protective casing and replace cap on inner well casing.
GW-28	Replace cap on inner well casing.
GW-38	Replace cap on inner well casing.
B-5	Replace/repair outer protective casing.
B-8	Replace/repair outer protective casing.

The project documents should be researched for reports of abandonment of GW-12. Possible replacement of this well will be evaluated as the long-term groundwater monitoring plan is developed.

To correct GW-20, the outer protective casing and inner well casing should be cut approximately one foot above ground level. A larger outer protective casing should then be installed over the existing outer protective casing and set in concrete. In addition a 1.5-ft-long section of inner well casing should be installed to replace the cut section of the inner well casing. This work is not required at this time but may be required and thus performed once the long-term groundwater monitoring plan is completed.

APPENDIX II

SDMS US EPA REGION V
FORMAT- OVERSIZED - 5
IMAGERY INSERT FORM

The item(s) listed below are not available in SDMS. In order to view original document or document pages, contact the Superfund Records Center.

SITE NAME	SKINNER		
DOC ID #	100262		
DESCRIPTION OF ITEM(S)	MAP-LEGEND		
REASON WHY UNSCANNABLE	_X_ OVERSIZED	OR	____ FORMAT
DATE OF ITEM(S)	01-01-1995		
NO. OF ITEMS	2		
PHASE	AR		
PRP			
PHASE (AR DOCUMENTS ONLY)	_X_ Remedial ____ Removal ____ Deletion Docket ___ AR ____ Original _X_ Update # _2_ Volume _2_ of _4_		
O.U.			
LOCATION	Box # _3_ Folder # _4_ Subsection _____		
COMMENT(S)			

APPENDIX III

EVALUATION OF GROUNDWATER INORGANIC DATABASE

The Phase II RI indicates that there was no surface water contamination by inorganics. The Phase II RI does not determine the significance of the inorganic detections in groundwater and refers the reader to the Risk Assessment for a statistical analysis of the inorganic compounds detected. The Risk Assessment identified 13 inorganics as chemicals of concern. These compounds included aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, zinc and cyanide. We have evaluated the database of inorganic detections to determine its significance.

To be a useful indictor that metals contamination is migrating away from the buried lagoon or landfill, the metal in question should have the following characteristics:

- Be consistently detected;
- Be detected only in wells spatially associated with the contaminant sources, OR, if found throughout the site, have either i) concentrations exceeding background levels primarily in wells spatially associated with the contaminant sources, or ii) have the highest concentrations primarily in wells spatially associated with the contaminant sources;
- Exceed applicable water quality standards primarily in wells spatially associated with the contaminant sources; and/or,

To determine which of USEPA's 13 inorganic "chemicals of concern" met these criteria, we prepared a database of the groundwater data from on-site monitoring wells. The data were then sorted by decreasing concentration for each of the 13 parameters and displayed as a series of bar graphs. Examination of these graphs is helpful in determining which parameters were consistently detected and in defining the background concentration (the procedure for this is described below).

From a preliminary evaluation of the Phase I data for Sampling Rounds 1 and 2, we concluded that the use of data for unfiltered samples (of which there were seven in Round 1, counting duplicates separately) resulted in substantially biased data for 7 of the 10 parameters that were consistently detected. Therefore, we excluded these data and data from residential well samples, which are also unfiltered, from further analysis.

Notes on Handling of Data

The database for the Phase I data (Sampling Rounds 1, 2, and 3) in USEPA's documents report only those parameters detected, and do not report the detection limits. (Thus, the absence of cadmium from this database does not mean that it was not analyzed for, simply that it was not detected). Non-detects in the Phase I data were entered in our database as very low numbers (0.00001 mg/L).

The database for the Phase II data report the detection limits for "non-detect" results. In its treatment of these data, USEPA used one-half the detection limit in its statistical analysis of the data. Thus, we entered these non-detects in our database as one-half of the reported detection limits.

Graphical Analysis

Because of the differences in the data, we prepared two graphs, which are included, for most of the parameters. The first graph separately sorts and plots the Phase I and Phase II data. Phase I data are designated on the bottom of the graphs as "F" (originally for filtered), and the Phase II data are designated as "A". The "A" portions of the graphs often show one or more plateaus representing the non-detect data. The fact that these are non-detects is important to keep in mind when examining the other graph, which combines the data in a single sorting. Combined plots were not done for several parameters (Cd, CN, and V) that showed strong differences between the Phase I and Phase II data. These differences were due to the very low number of detections in either or both of the phases.

Several of the graphs show a marked break in trend that separates a lesser number of high values from a greater number of low values. The graphs for barium and zinc show the best examples of this feature. This break point is taken as the background concentration. Some graphs showed no definable break and no background could be assigned.

If a background concentration could be defined, then we determined at which wells the background value was exceeded. If a background concentration could not be defined, we determined where the wells with the highest concentrations were located. For each well in question, we noted the number of exceedences or detections (as appropriate) out of the total number of sampling events from that well. We also noted if there was a primary or secondary drinking water MCL, and determined at which wells, if any, it was exceeded. This information was considered and based on best professional judgment, be made a recommendation for monitoring, if appropriate. This information is summarized in Table 1. The primary and secondary drinking water standards are from Rule 3745-81-11 of the Ohio Administrative Code.

Recommendations

- Aluminum – This compound is consistently detected above background, and has no potential for excess health risk. Therefore, quarterly monitoring is not appropriate.

- Arsenic – This compound is fairly consistently detected above background, particularly at GW20 which is adjacent to sources, and there is an increasing concentration trend in GW20 exceeding the primary MCL.

- Barium – Barium is consistently detected above background in several wells spatially associated with sources, and the primary MCL is exceeded in GW20. We recommend monitoring for Barium.

- Cadmium – There were only two detections of cadmium in wells during the entire sampling. We do not recommend monitoring for cadmium.

- Chromium - Detections of chromium above background are infrequent, not consistent and not in wells spatially associated with sources. The concentrations are below primary MCL, and we do not recommend monitoring for chromium.

- Cobalt -- There are somewhat consistent detections in wells that are not spatially oriented to indicate groundwater impact. There have been no exceedences of the MCL. We recommend continued monitoring.

- Copper -- There was no definable background concentration, and detections were scattered throughout the site, with the highest detections not associated with the sources. The maximum concentration (0.015 mg/L) is well below the secondary MCL (1.0 mg/L). We do not recommend monitoring for copper.

- Lead -- There was no definable background concentration and detections were scattered across the site. The seven highest concentrations are in wells screened in bedrock, which consists of interbedded limestone and shale, and lead sulfide minerals are a common trace mineral in such shales. We do not recommend monitoring for lead.

- Manganese -- There are detections exceeding background scattered throughout the site, and the highest concentrations are not in and or adjacent to sources. We do not recommend monitoring for manganese.

- Nickel -- The data indicates consistent detections and the highest concentrations in wells spatially associated with sources. We recommend monitoring for nickel.

- Vanadium -- There was only one detection in the Phase I data, and multiple detections in Phase II data. The Phase II data is all "qualified" as Vanadium was detected in the blank; and this suggests that the detections are artifact of some aspect of Phase II sampling and/or analysis. We do not recommend monitoring for Vanadium.

- Zinc -- The detections exceed background and the highest concentrations at wells in or adjacent to sources. We recommend monitoring for zinc.

- Cyanide -- There were only two detections in the entire database. We do not recommend continued monitoring for this compound.

TABLE 1

EVALUATION DATA SUMMARY

1. Aluminum

Estimated Background 0.100 mg/L

Background Exceeded at:

Well #	# of Exceedences/ # of Sampling Events
GW06	1/3
GW12	1/5
GW20	1/4
GW22	1/2

Applicable Water Quality Standard No P or S MCL

No Monitoring Recommended.

2. Arsenic

Estimated Background 0.010 mg/L

Background Exceeded at:

Well #	# of Exceedences/ # of Sampling Events
GW09	1/4
GW17	3/4
GW18	2/3
GW20	4/4
B5	1/1

Applicable Water Quality Standard P MCL - 0.050 mg/L

Monitoring Recommended.

3. Barium

Estimated Background 0.250 mg/L

Background Exceeded at:

Well #	# of Exceedences/ # of Sampling Events
GW06	1/3
GW07	1/5
GW09	3/4
GW10	2/4
GW19	1/3
GW20	3/4
GW30	1/1
GW31	2/2
GW35	1/1
GW38	1/1

Applicable Water Quality Standard P MCL - 1.0 mg/L

Exceeded at:

GW06	1/3
GW20	1/4

Monitoring Recommended.

4. Cadmium

Estimated Background: Not definable

Detected at:

GW06	0.0025 mg/L
GW32	0.0037 mg/L

Both are "B" qualified (found in blank)

Applicable Water Quality Standard: P MCL - 0.010 mg/L

Monitoring Not Recommended.

5. Chromium

Estimated Background: 0.0075 mg/L

Exceeded at:

Well #	# of Exceedences/ # of Sampling Events
GW06	1/3
GW15	1/5
GW19	1/3
GW22	2/2
GW23	1/3
GW30	1/1

Applicable Water Quality Standard: P MCL - 0.050 mg/L

Monitoring Not Recommended.

6. Cobalt

Estimated Background: Not definable

Detected at:

Well #	# of Exceedences/ # of Sampling Events
GW10	2/4
GW11	1/3
GW12	3/5
GW15	1/5
GW16	1/2
GW20	1/4
GW22	2/2
GW23	1/3

Applicable Water Quality Standard: None

Monitoring recommended.

7. **Copper**

Estimated Background: Not definable

Detected at: Various locations throughout the site with no spatial relationship to sources.

Applicable Water Quality Standard: S MCL - 1.0 mg/L

The secondary MCL was not exceeded, and the maximum concentration measured was 0.015 mg/L.

Monitoring not recommended.

8. **Lead**

Estimated Background: Not definable

Detected at: Locations throughout the site. The seven highest concentrations (0.008 mg/L to 0.034 mg/L) occurred in wells screened in bedrock. Lead sulfide minerals are common trace constituents in shales.

Applicable Water Quality Standard: P MCL 0.050 mg/L

Monitoring not recommended.

9. **Manganese**

Estimated Background: 0.900 mg/L

Detected at:

Well #	# of Exceedences/ # of Sampling Events
GW07	1/5
GW11	1/3
GW12	4/5
GW15	4/5
GW16	2/2
GW17	4/4
GW18	2/3
GW20	2/4
GW21	1/1

Applicable Water Quality Standard: S MCL - 0.050 mg/L

Exceeded at: Numerous locations on the site with no spatial relationship to sources.

Monitoring not recommended.

10. **Nickel**

Estimated Background: Not definable

Detected at:

Well #	# of Exceedences/ # of Sampling Events
GW07	1/5
GW10	2/4
GW11	1/3
GW12	5/5
GW15	2/5
GW16	2/2
GW17	2/4
GW18	1/3
GW20	4/4
GW22	1/2
GW23	1/3

Applicable Water Quality Standard: None

Monitoring recommended.

11. **Vanadium - Not Definable**

There was only one detection in the Phase I data. All other detections were in the Phase II data and were "B" qualified, suggesting laboratory or sampling artifact.

Monitoring is not recommended.

12. **Zinc**

Estimated Background: 0.030 mg/L

Exceeded at:

Well #	# of Exceedences/ # of Sampling Events
GW12	3/5
GW17	2/4
GW20	2/4
GW22	1/2
B5	1/1

Applicable Water Quality Standard: S MCL - 5.0 mg/L

The S MCL was not exceeded, but there is a good spatial relationship to sources.

Monitoring is recommended.

13. **Cyanide**

Estimated Background: Not definable

Detected at:

GW11	0.011 mg/L
GW20	0.0235 mg/L

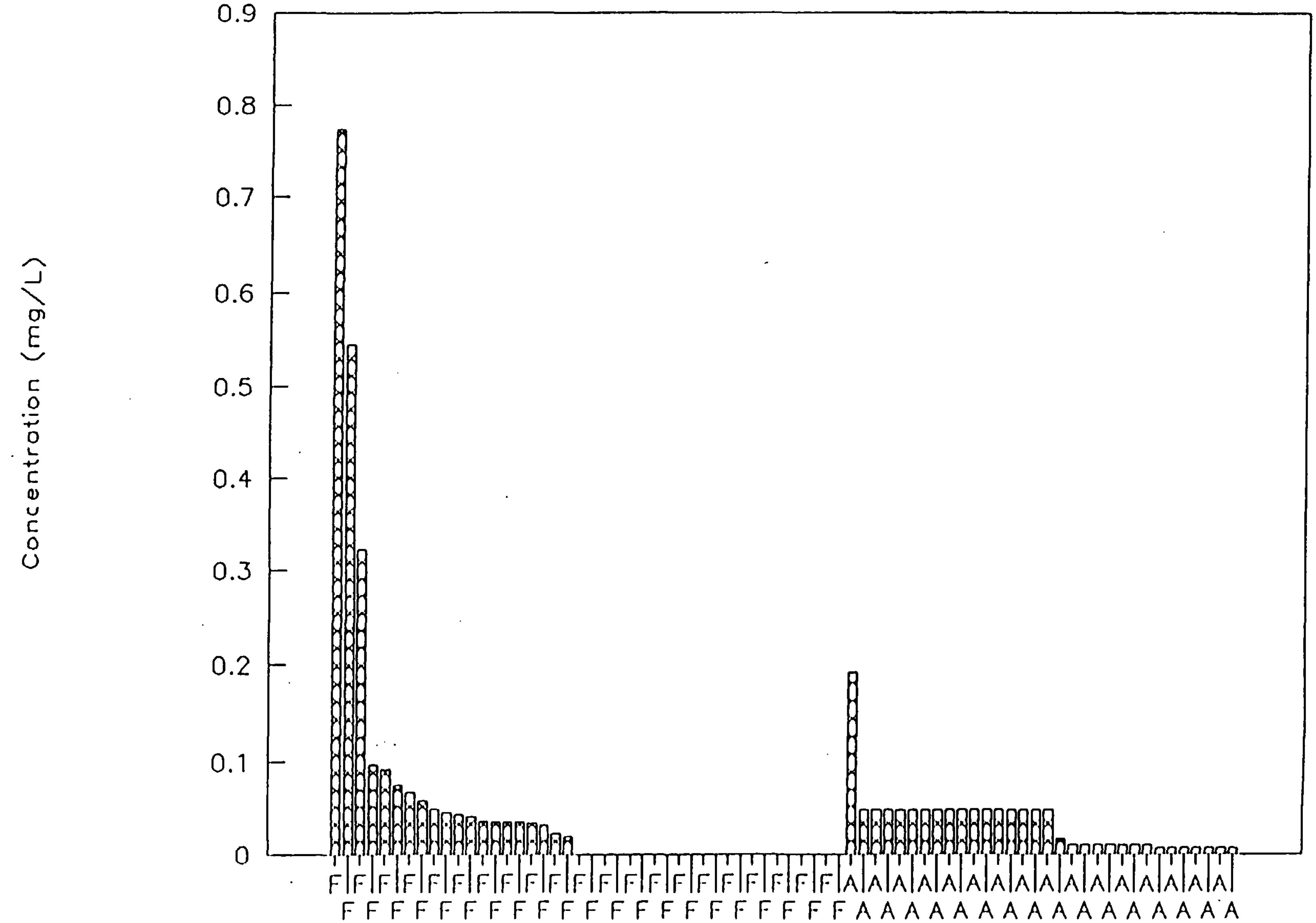
The lack of detections indicate that monitoring is not necessary.

Monitoring is not recommended.

llb
c:\word5\skinner.doc
January 26, 1993

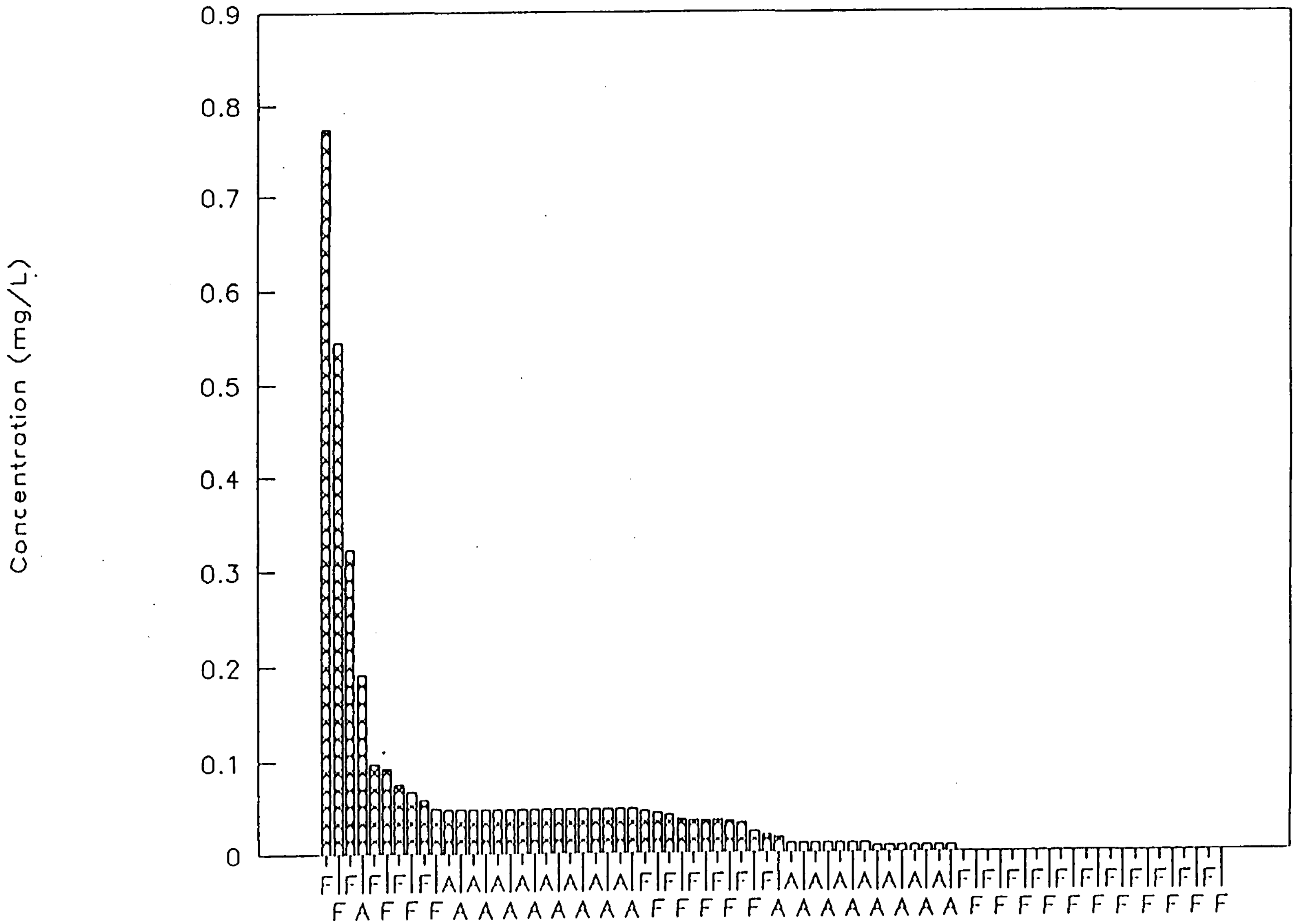
Skinner Landfill GW Metals

Aluminum



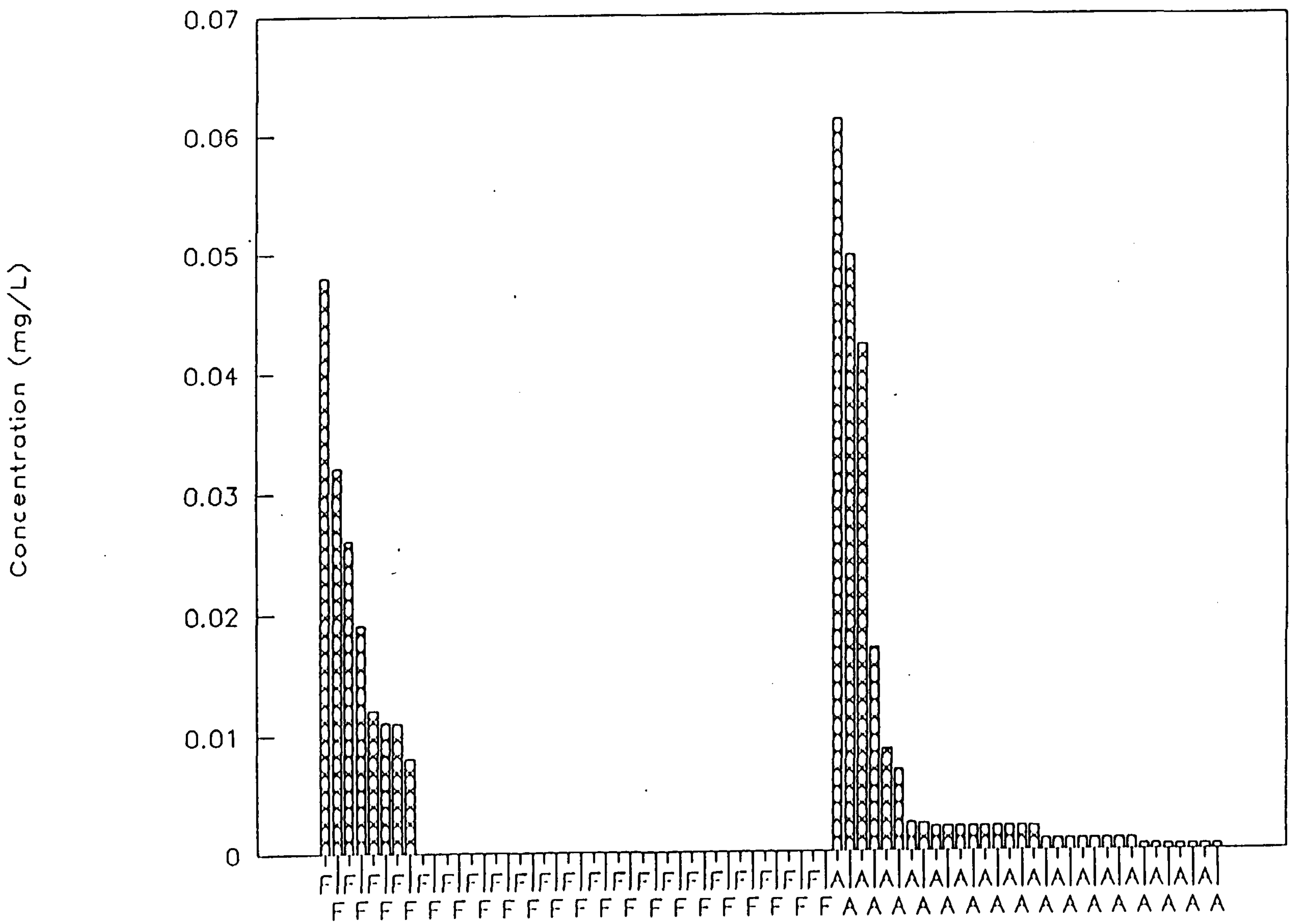
Skinner Landfill GW Metals

Aluminum



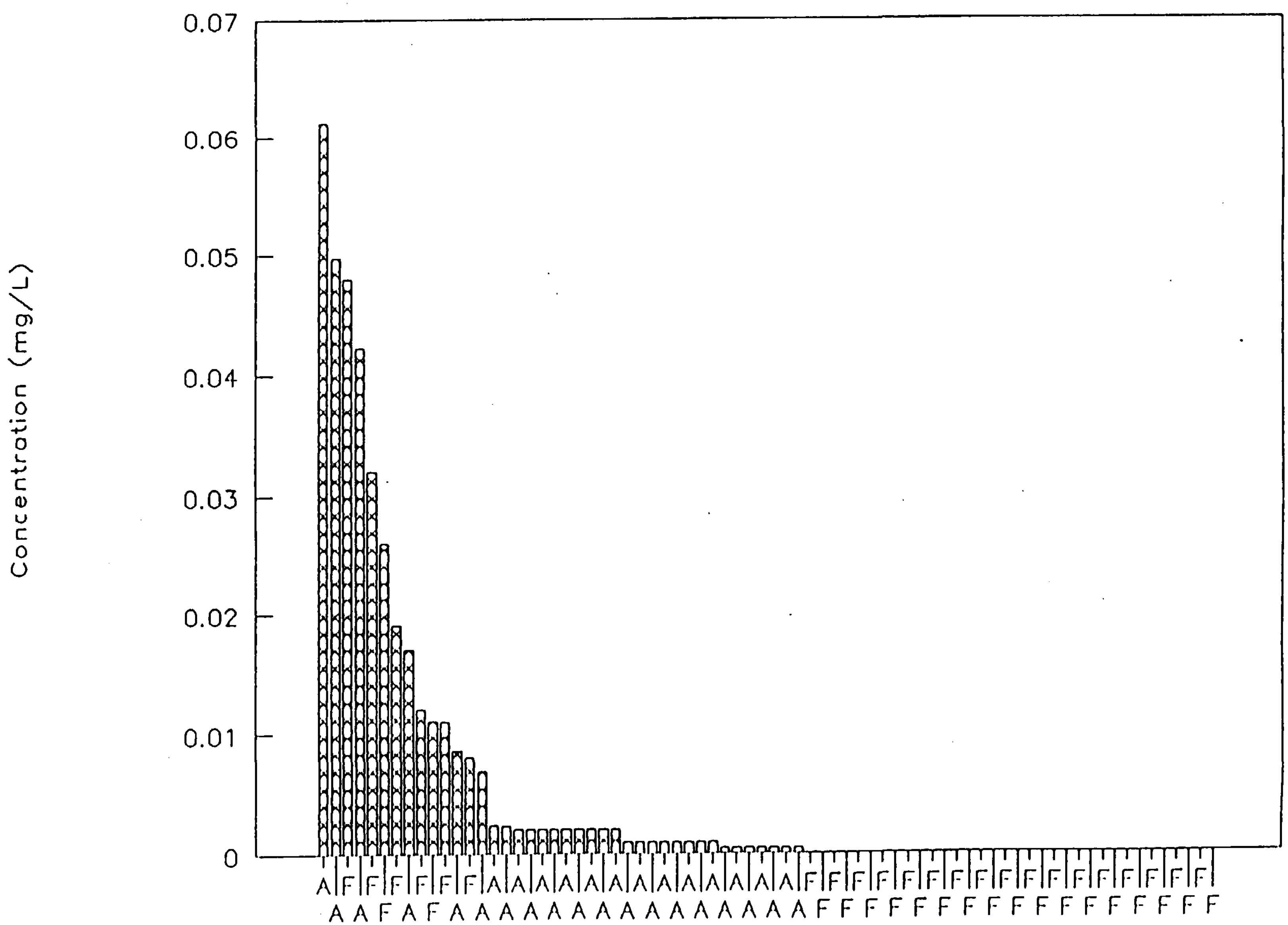
Skinner Landfill GW Metals

Arsenic



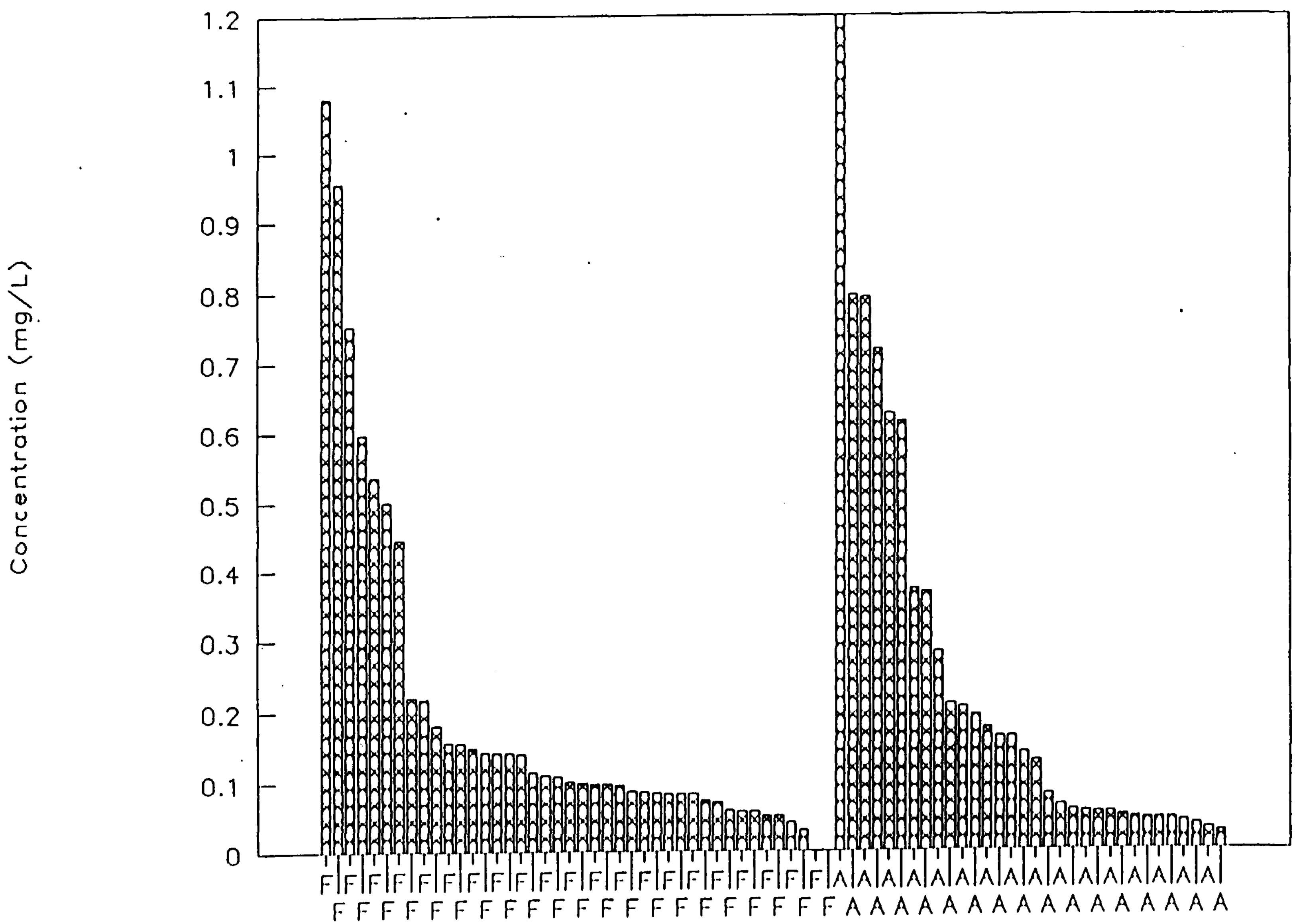
Skinner Landfill GW Metals

Arsenic



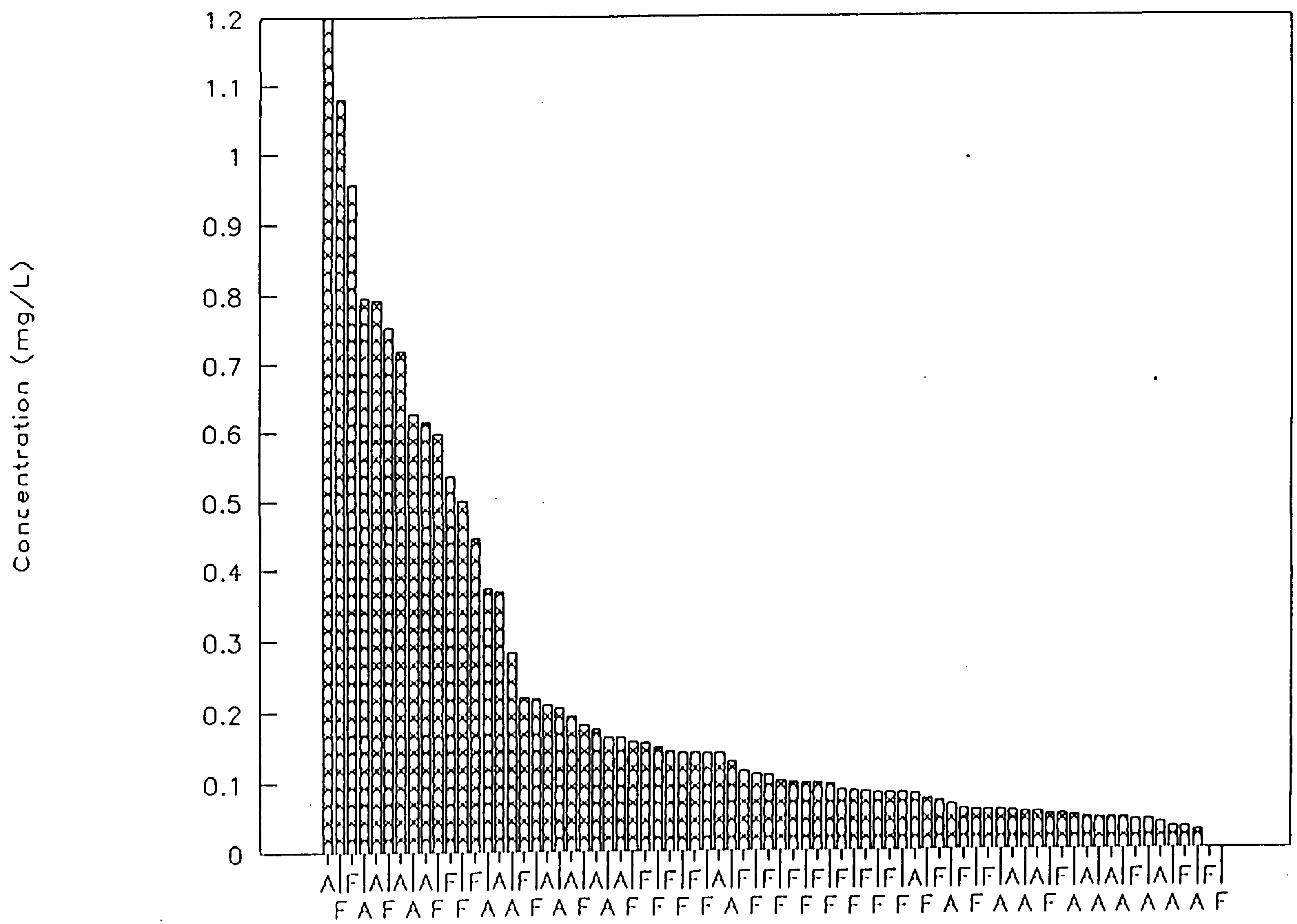
Skinner Landfill GW Metals

Barium



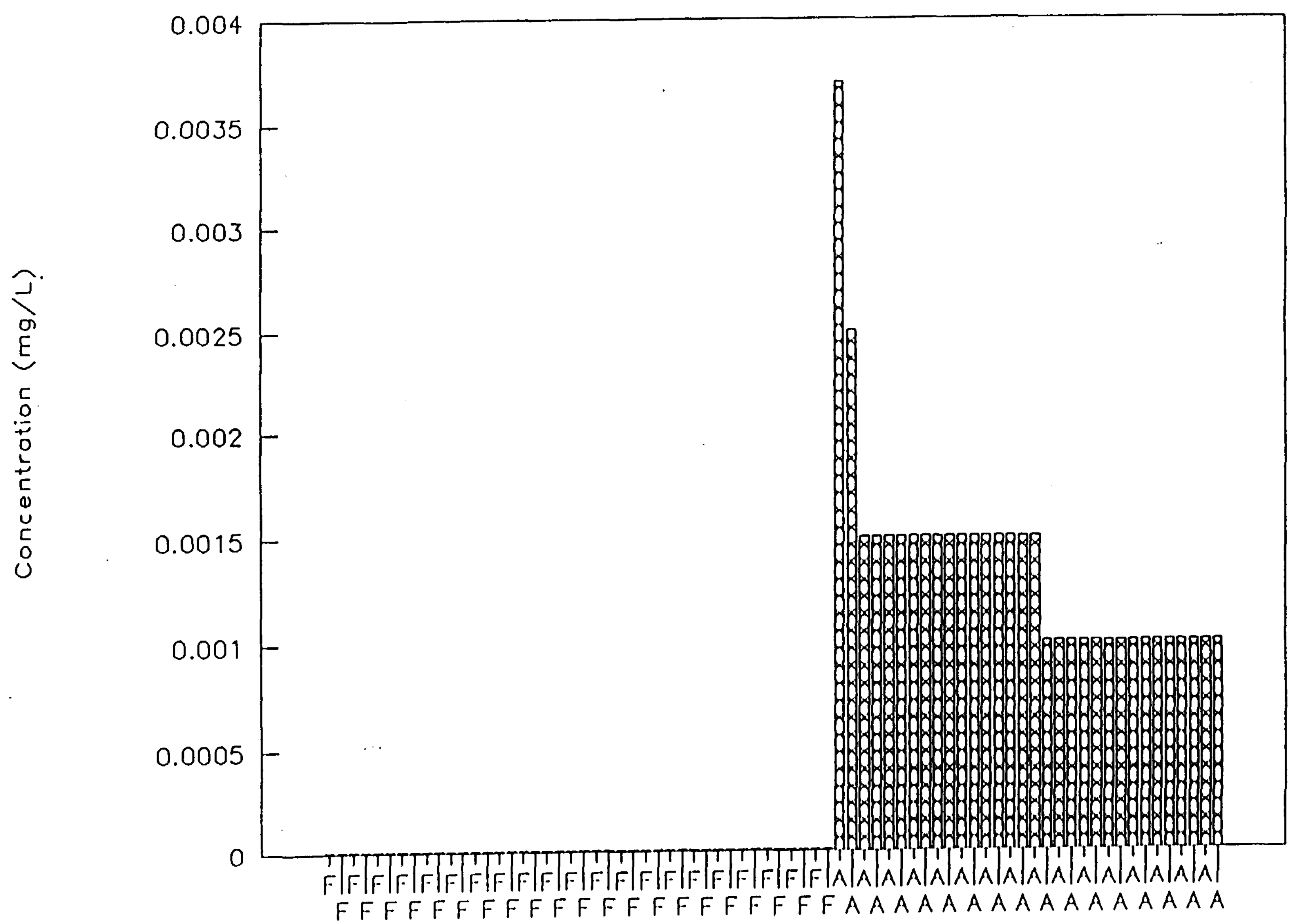
Skinner Landfill GW Metals

Barium



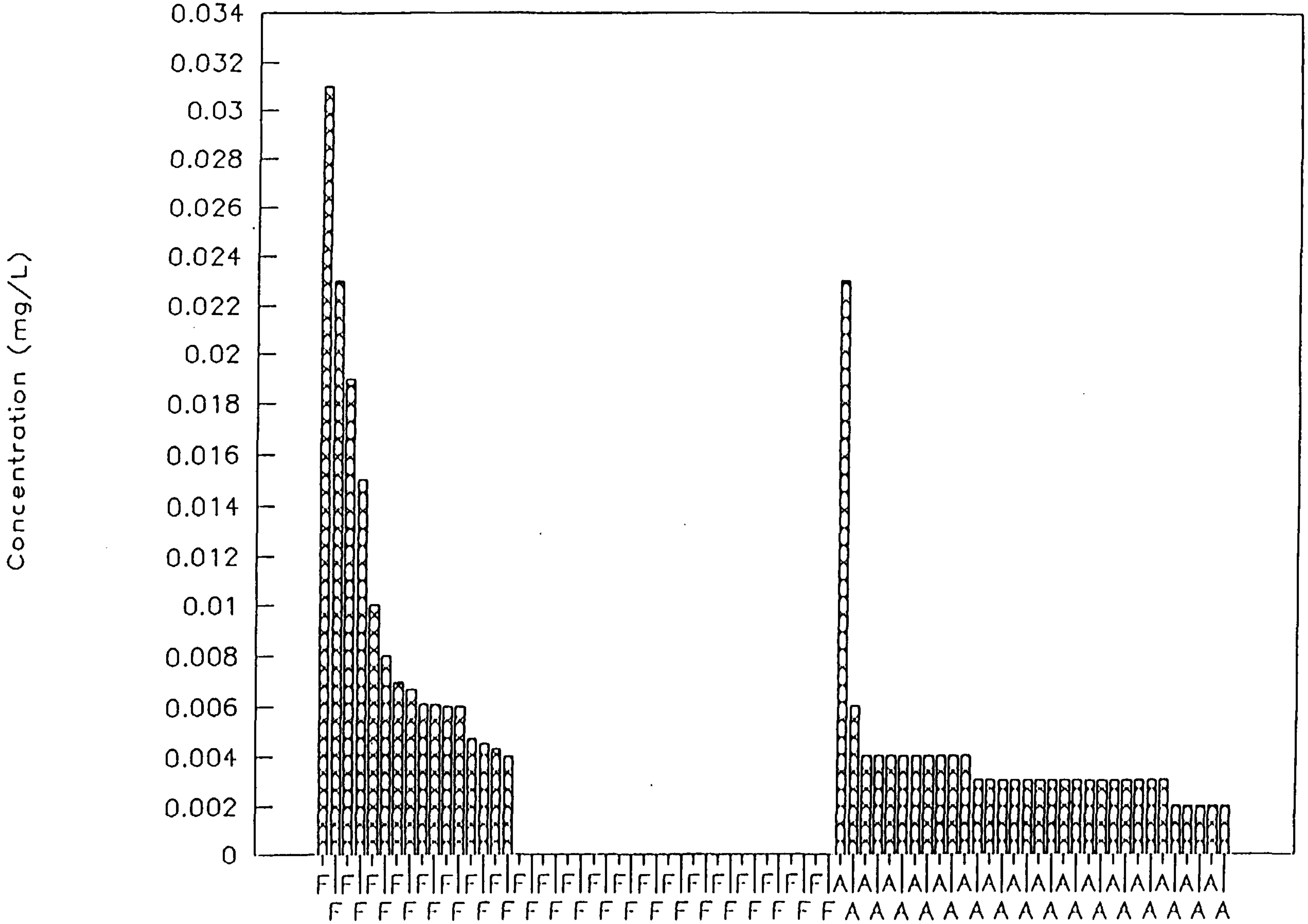
Skinner Landfill GW Metals

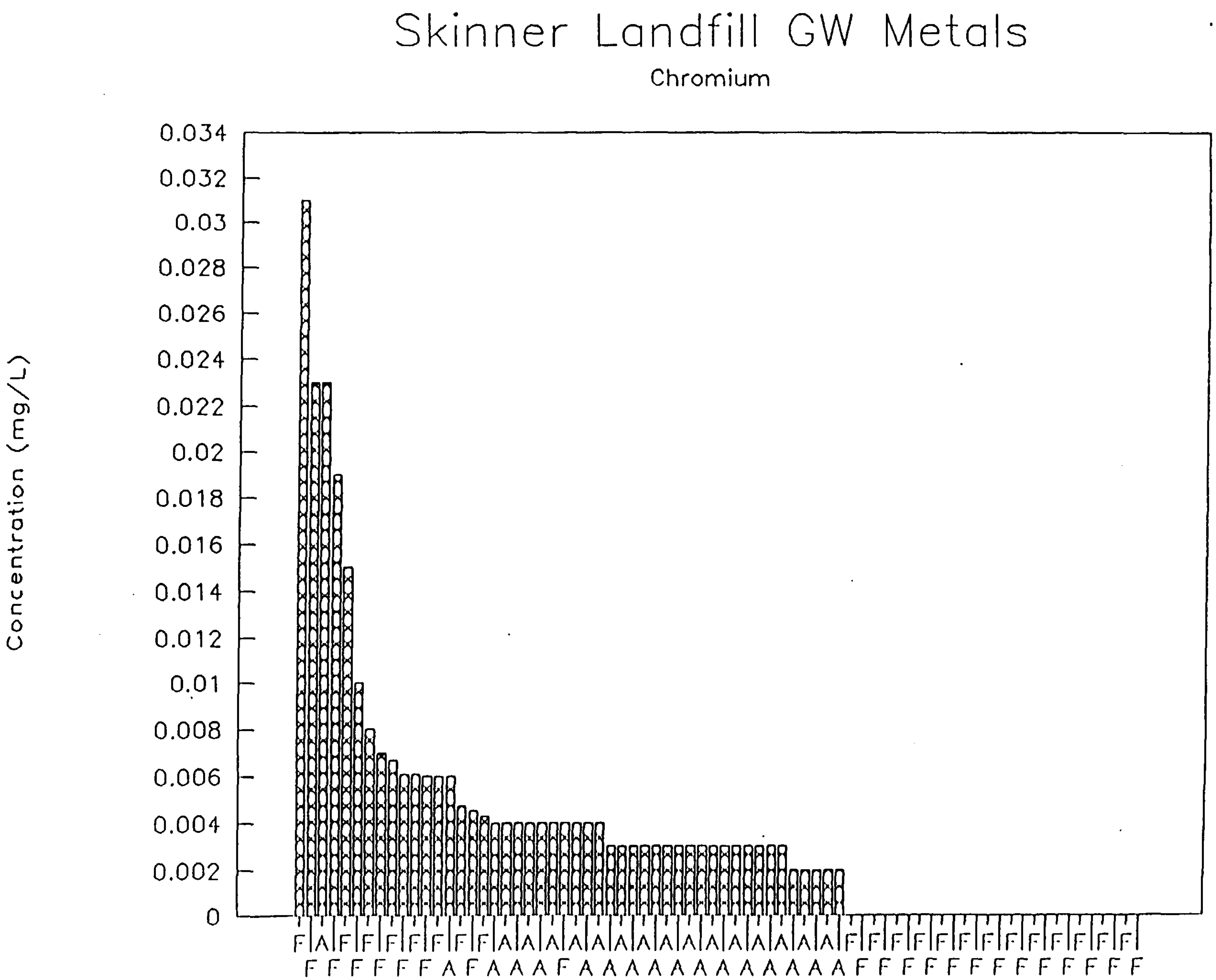
Cadmium



Skinner Landfill GW Metals

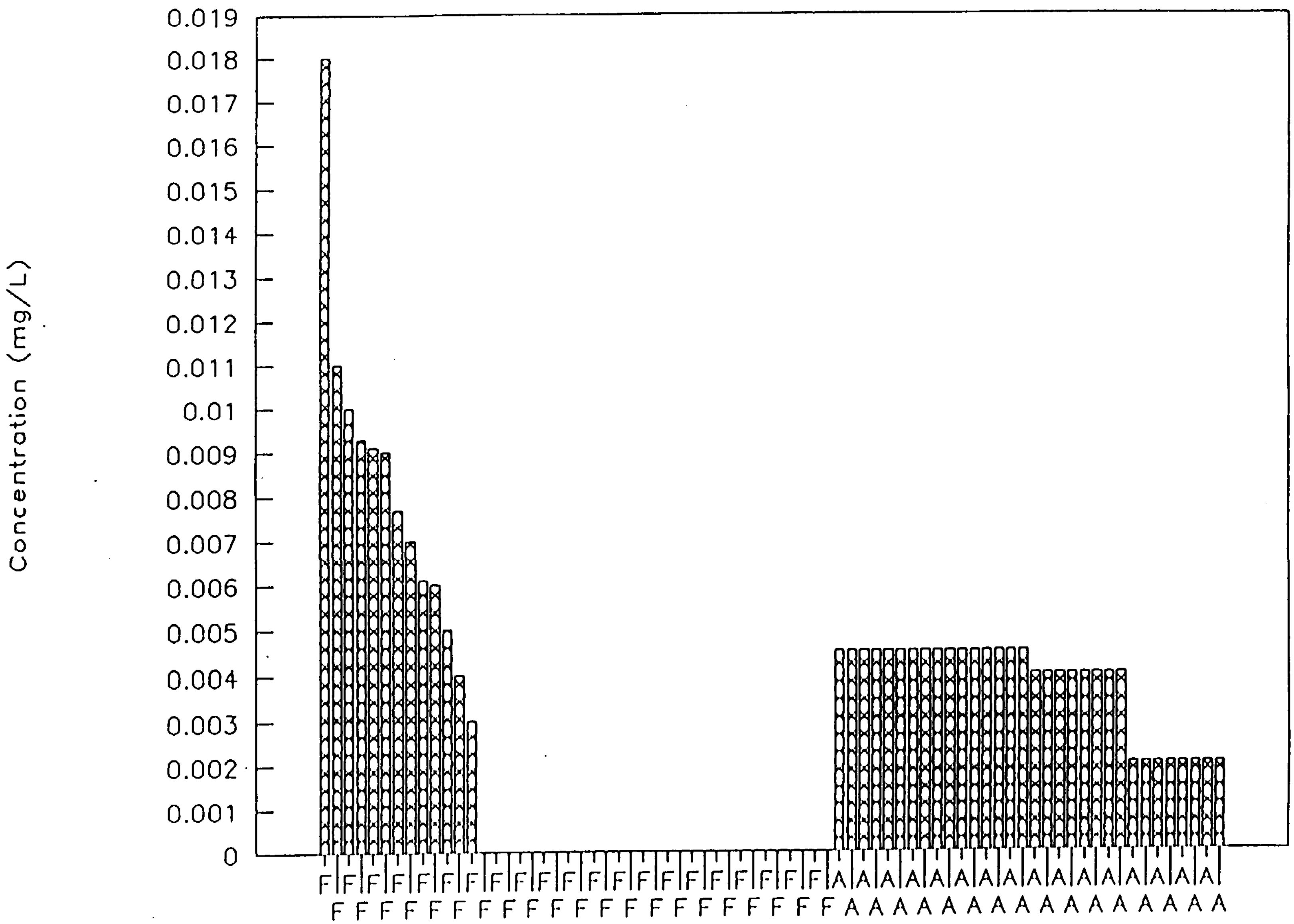
Chromium




Skinner Landfill GW Metals
Chromium
Concentration (mg/L)
0.034
0.032
0.03
0.028
0.026
0.024
0.022
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0

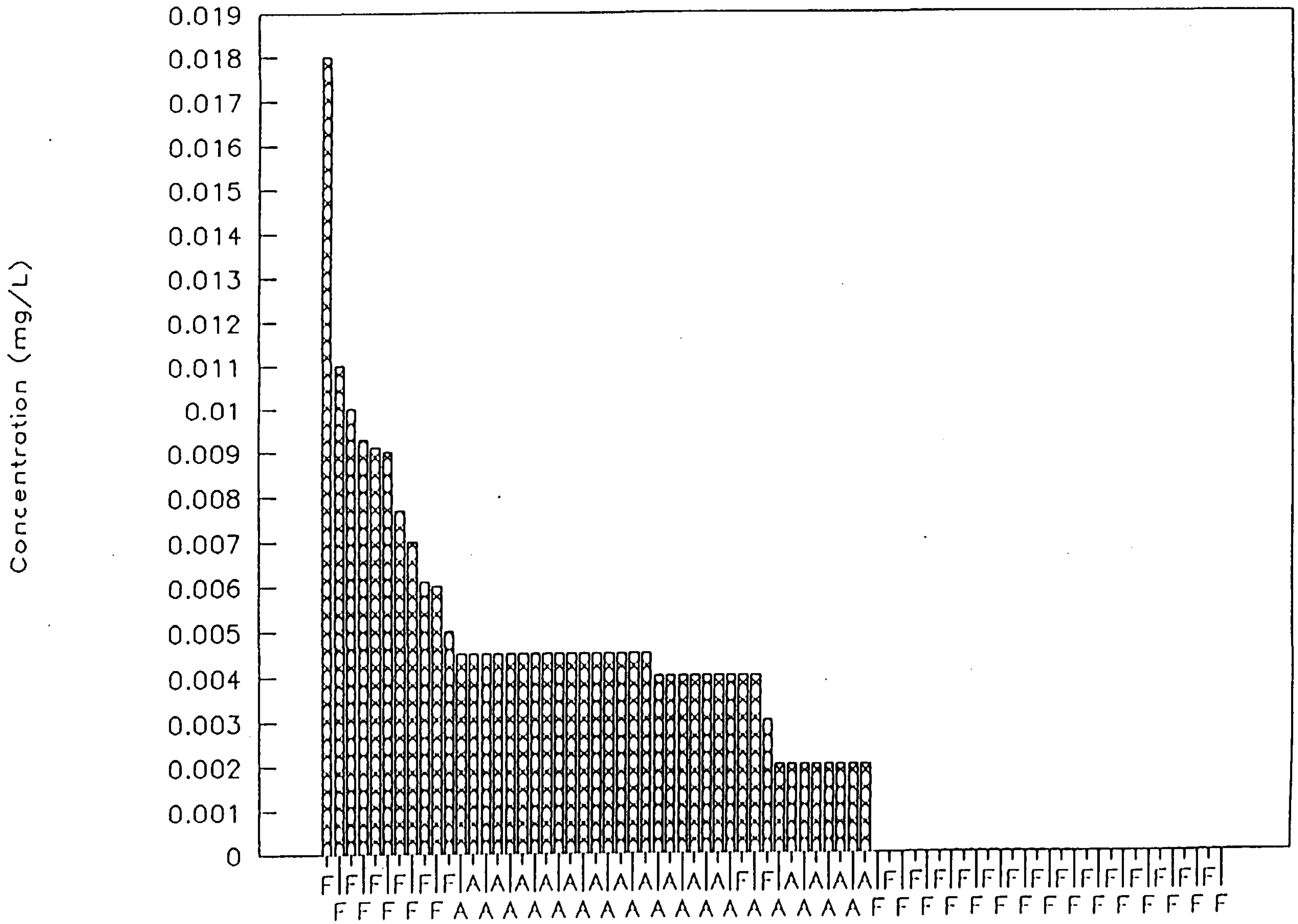
Skinner Landfill GW Metals

Cobalt



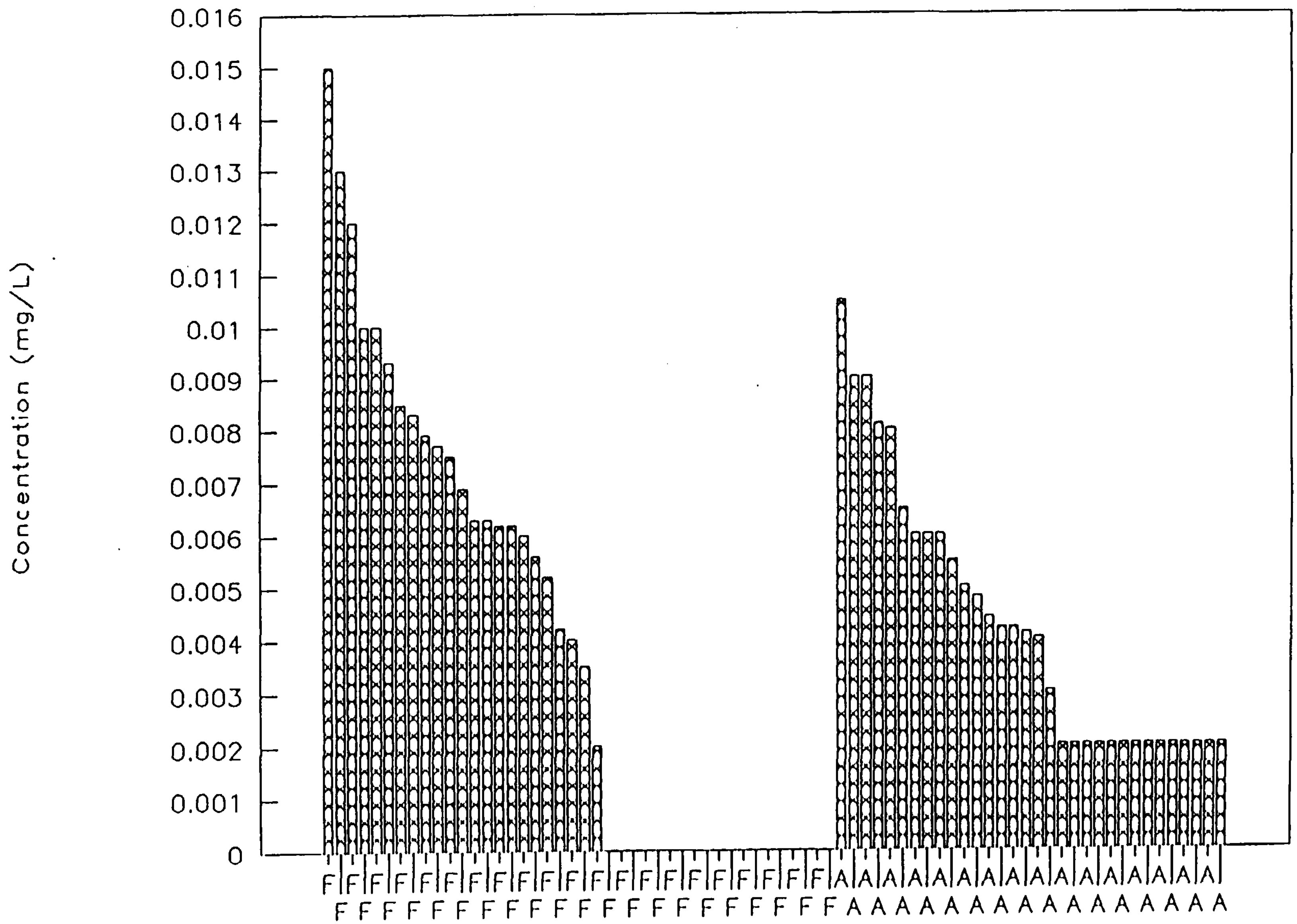
Skinner Landfill GW Metals

Cobalt



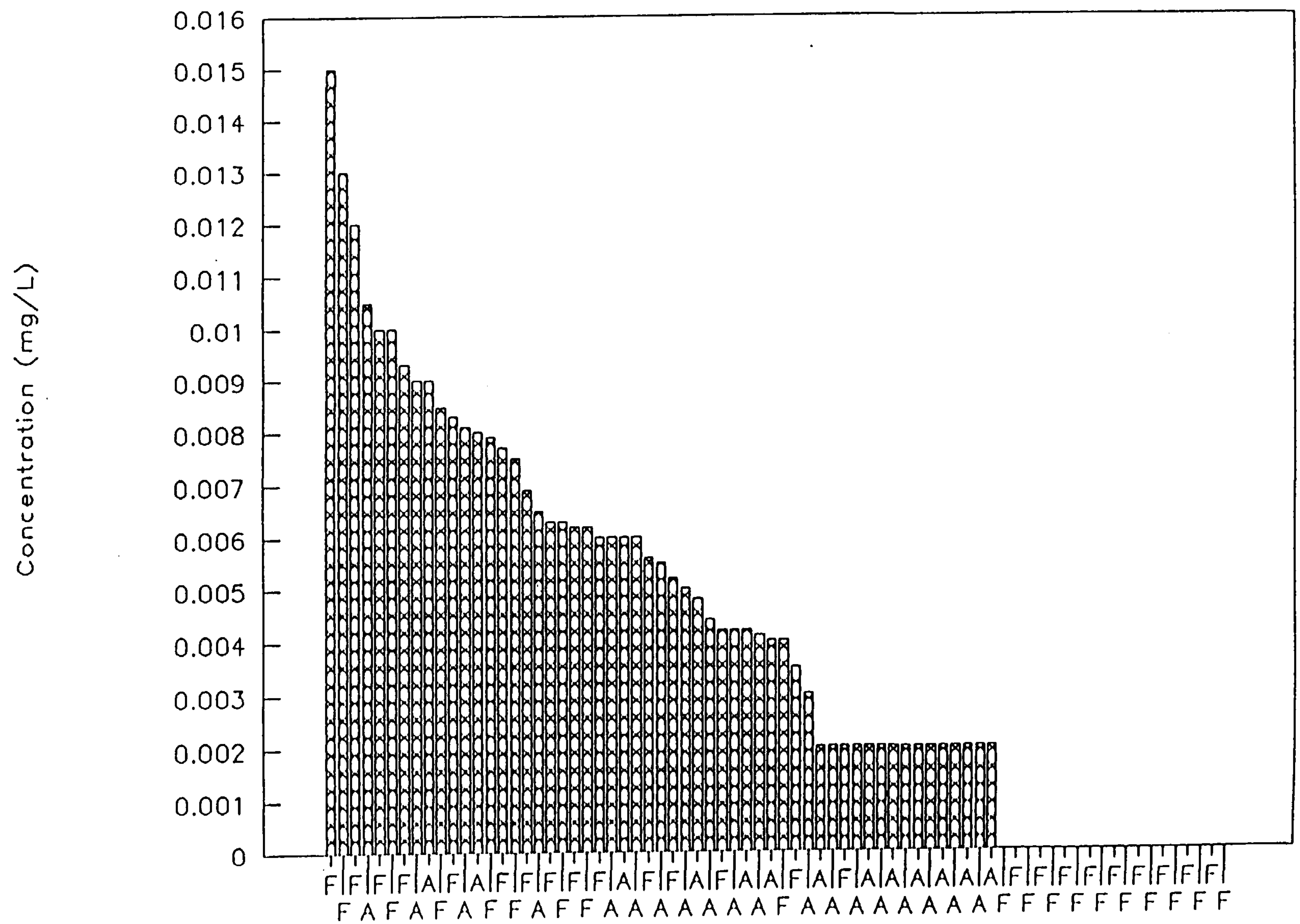
Skinner Landfill GW Metals

Copper



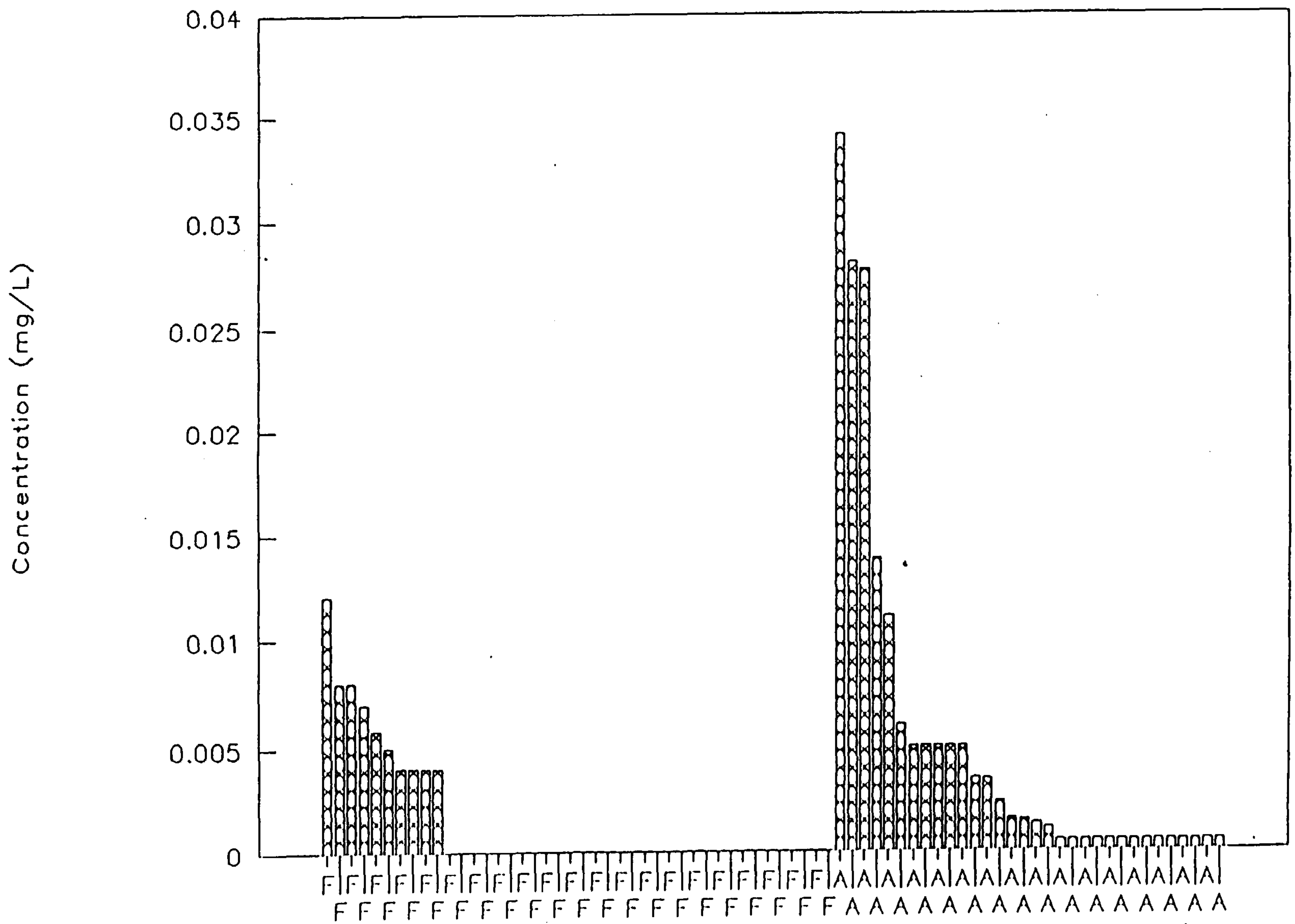
Skinner Landfill GW Metals

Copper



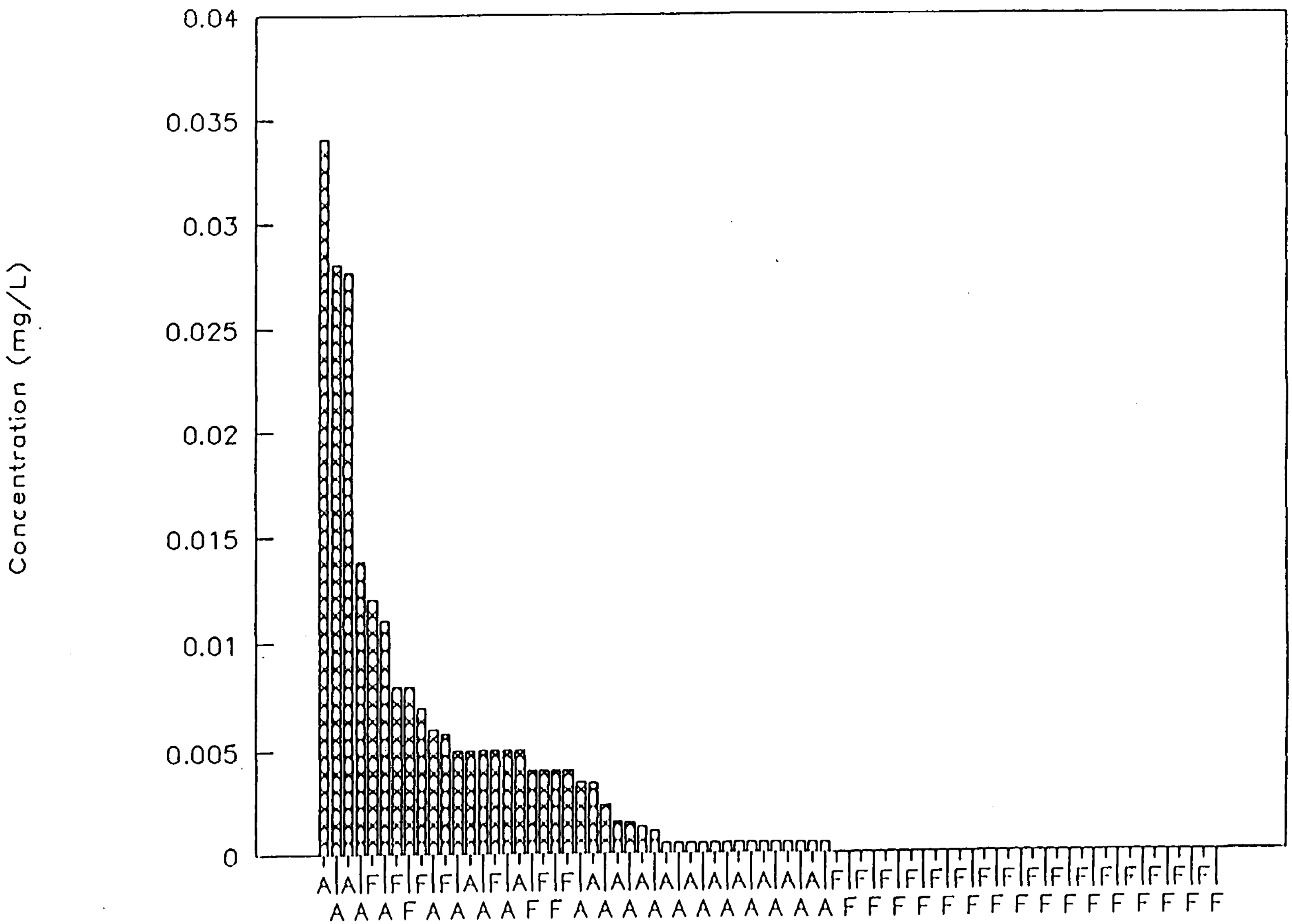
Skinner Landfill GW Metals

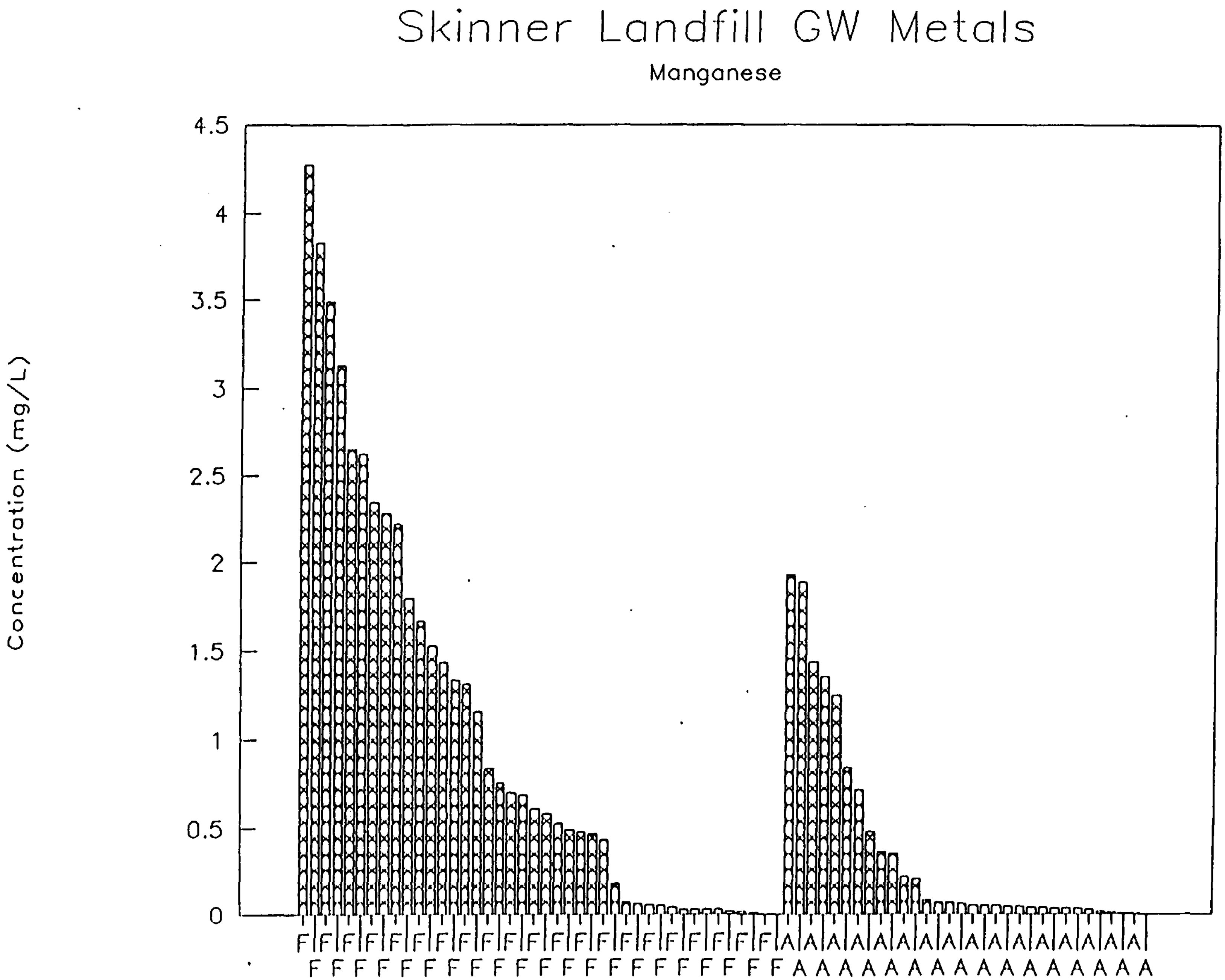
Lead



Skinner Landfill GW Metals

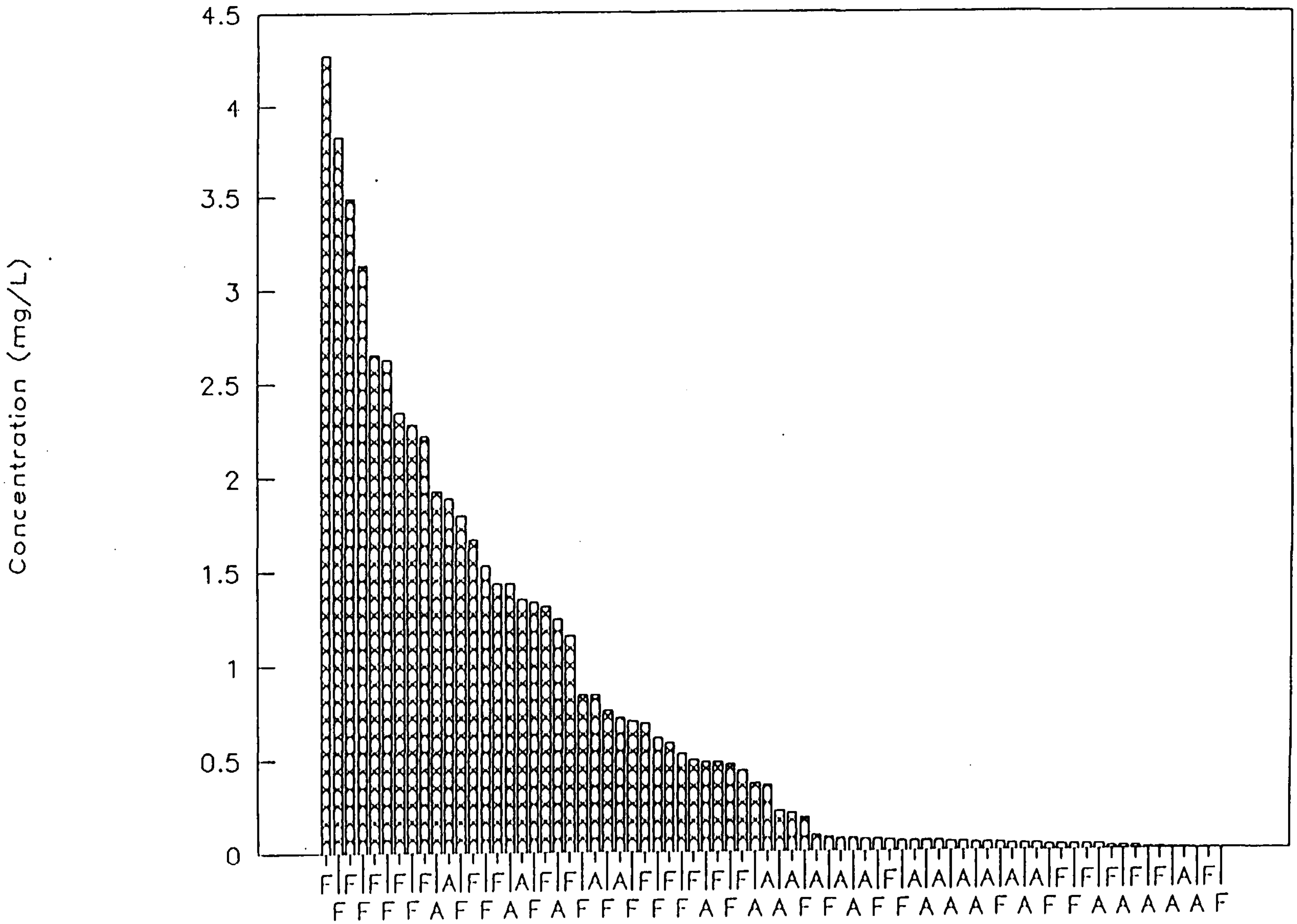
Lead




Skinner Landfill GW Metals
Manganese
Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0

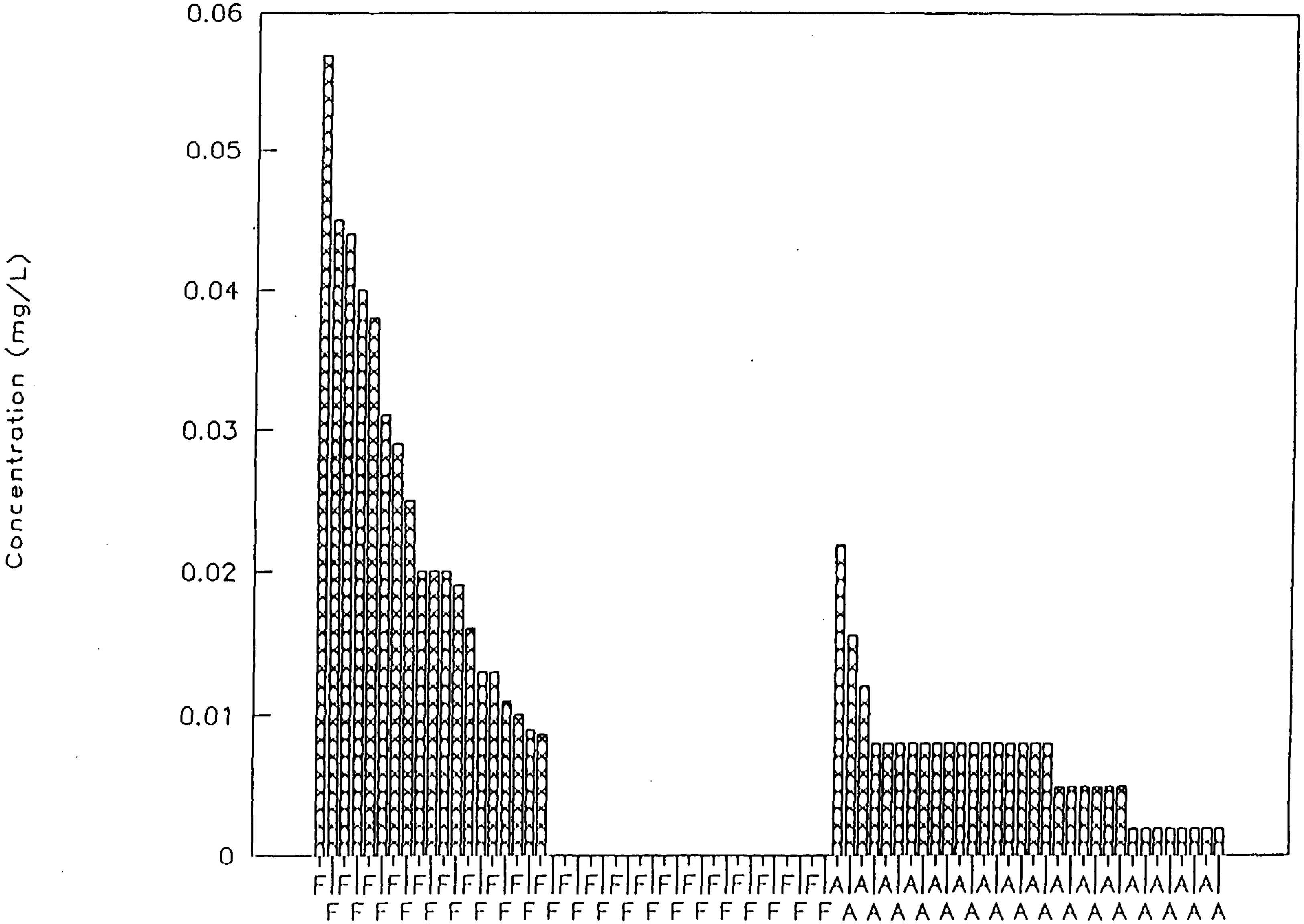
Skinner Landfill GW Metals

Manganese



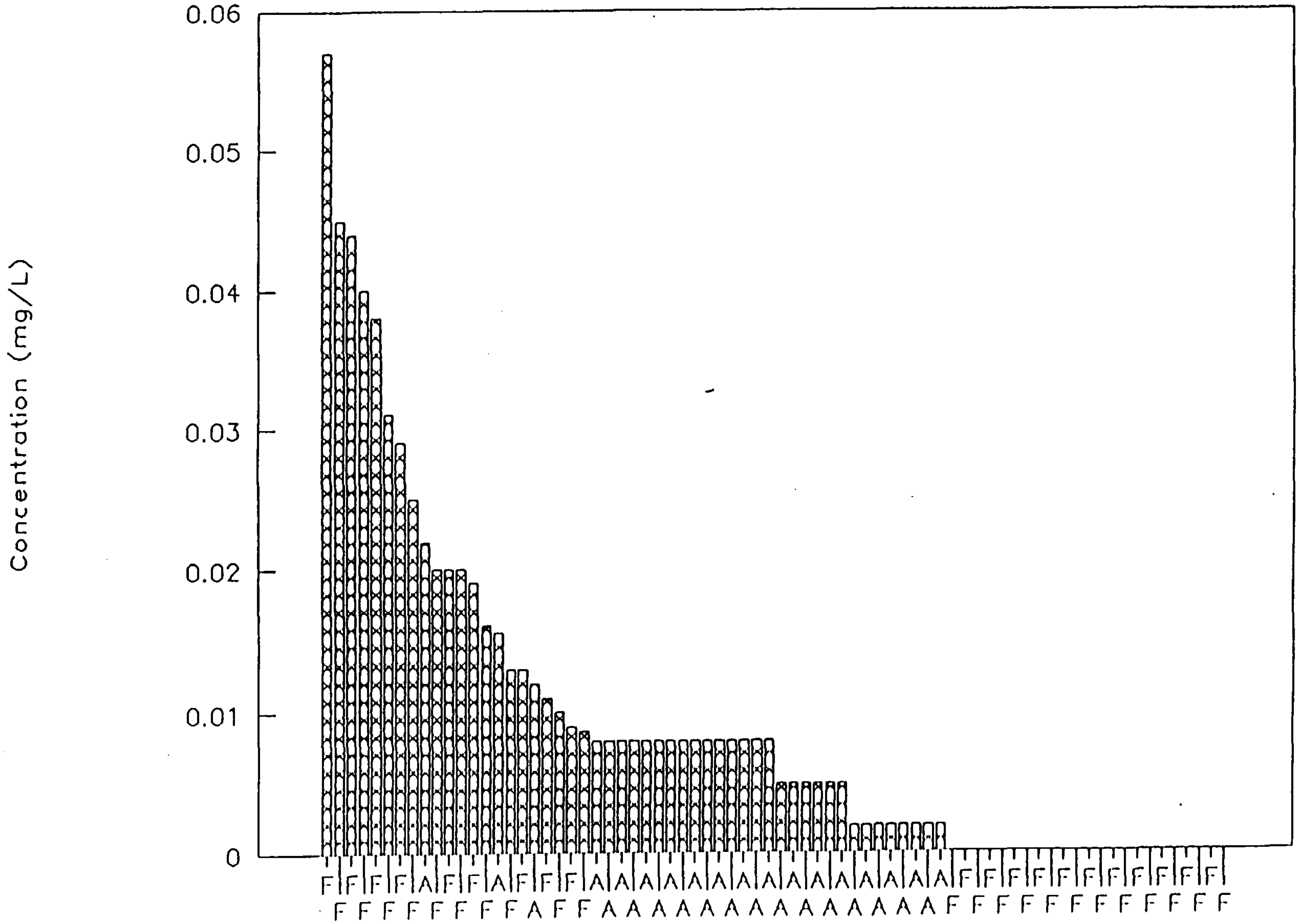
Skinner Landfill GW Metals

Nickel



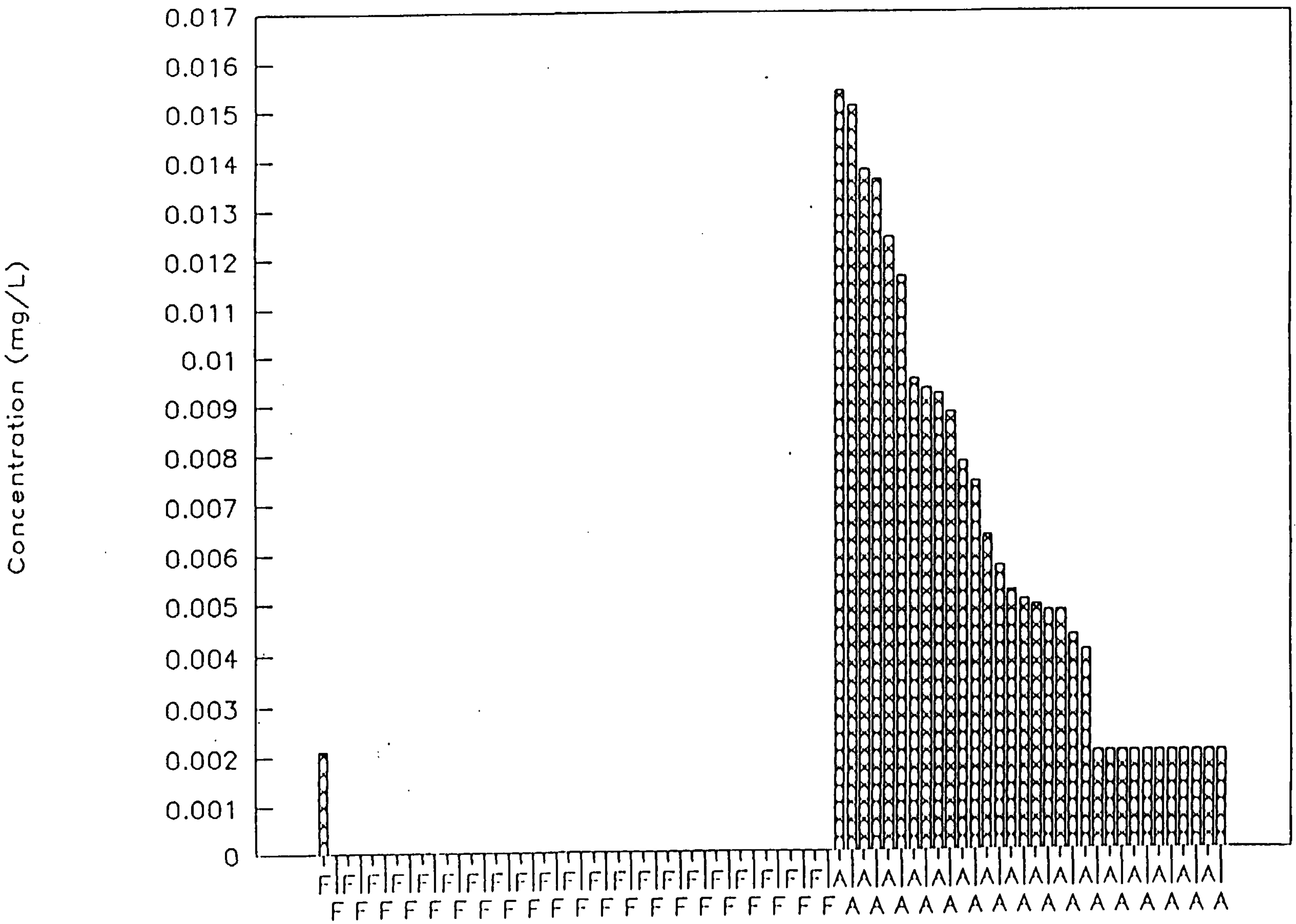
Skinner Landfill GW Metals

Nickel



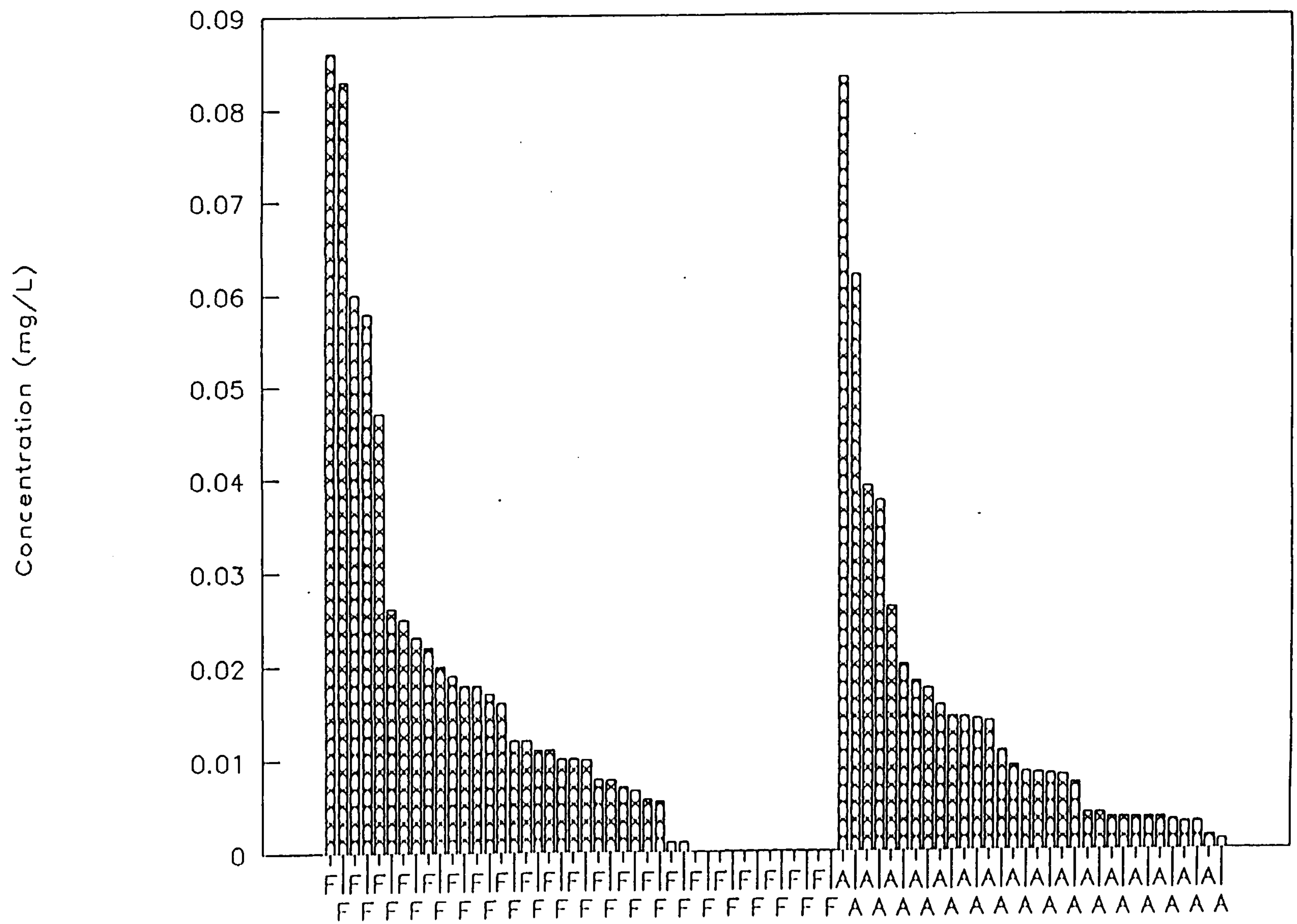
Skinner Landfill GW Metals

Vanadium



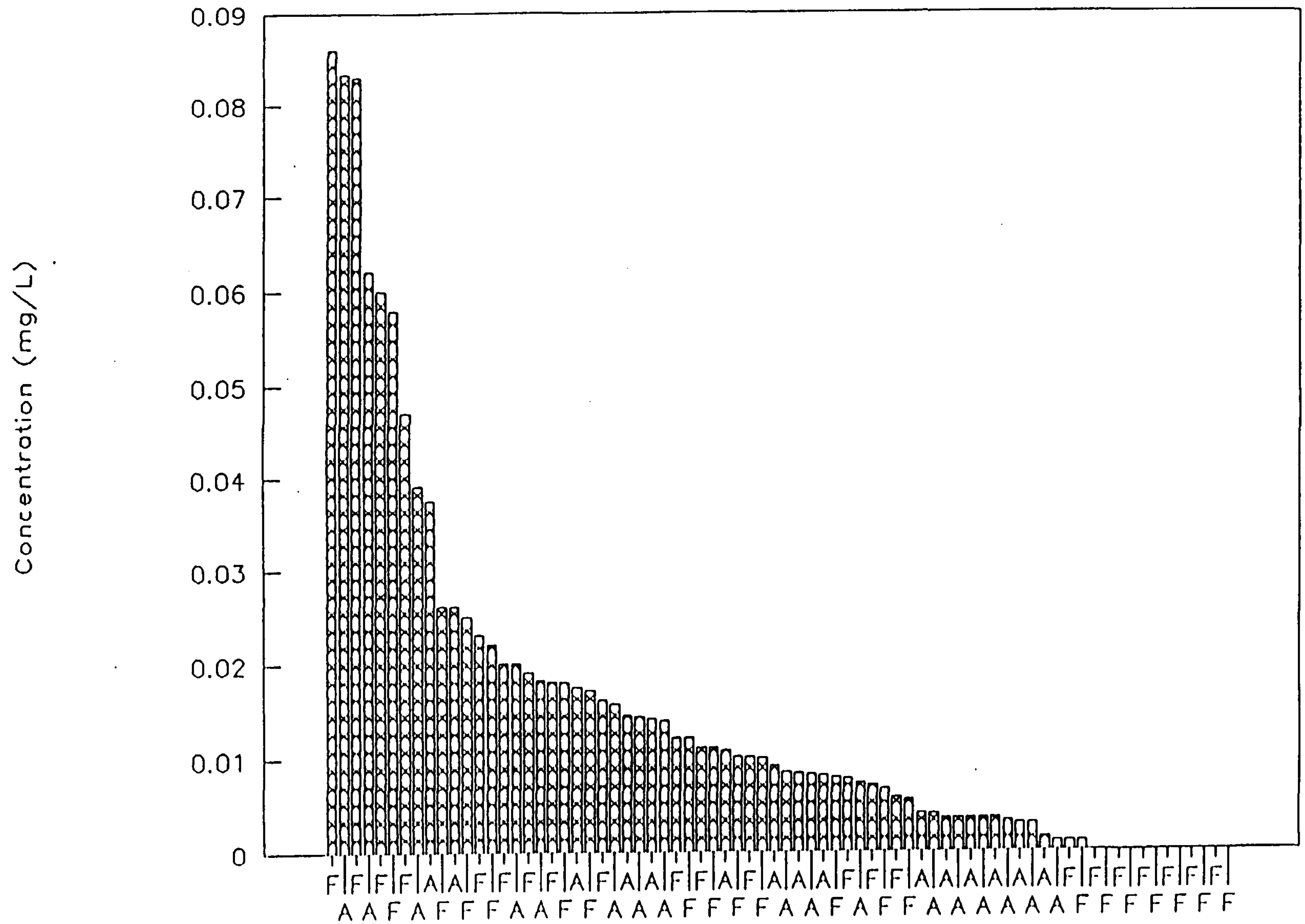
Skinner Landfill GW Metals

Zinc



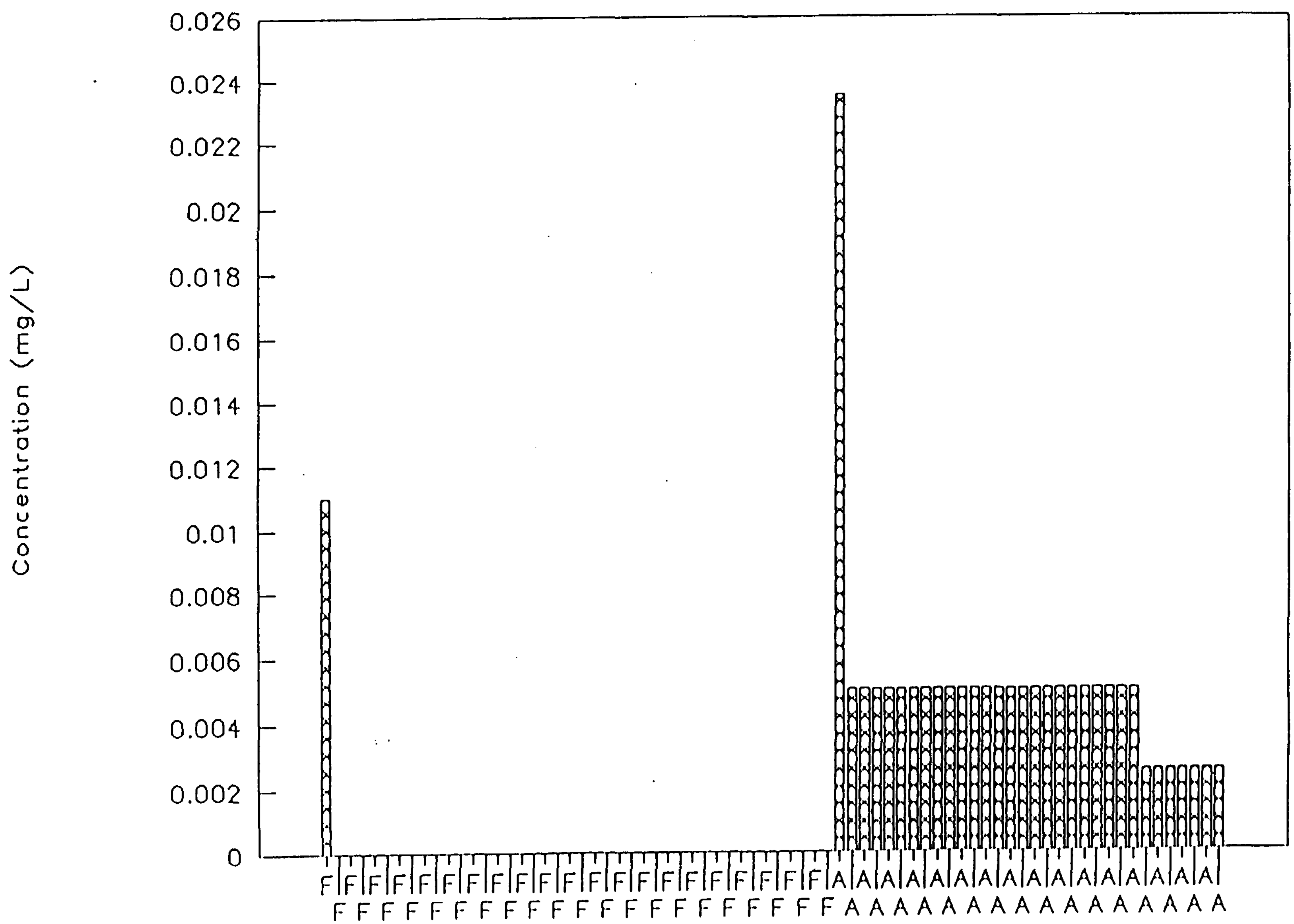
Skinner Landfill GW Metals

Zinc



Skinner Landfill GW Metals

Cyanide



$\int$ **IV**

APPENDIX IV

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72880.300

LOG OF BORING NO. GW-50

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 883.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Dark brown (10yr 3/3) SILT, 10% clay, 5% rounded gravel, low plasticity, very hard, moist.	SS	4	0.3			100
		Dark grayish brown (10yr 4/2) SILT, 20% sand, 10% angular gravel, very stiff, dry.	SS	3	0.2			18
5			SS	8	0.2	878.8		14
		Gray (10yr 5/1) CLAY, 10% silt, 10% sand, 7% subrounded to rounded gravel, low plasticity, very stiff, moist. (TILL)	SS	12	0.2			18
		Same. Thin coarse sand seam at 9.5 ft., very stiff, moist.	SS	10	0.4			18
10		Gley 5/1 CLAY, 5% rounded gravel, 2% sand, medium plasticity, stiff, damp. (TILL)	SS	7	0.5	873.8		14
		Same, saturated.	ST	ND	ND			

DATE STARTED: 10-21-94	DATE FINISHED: 10-26-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: D. Roetker
WATER LEVEL: --	

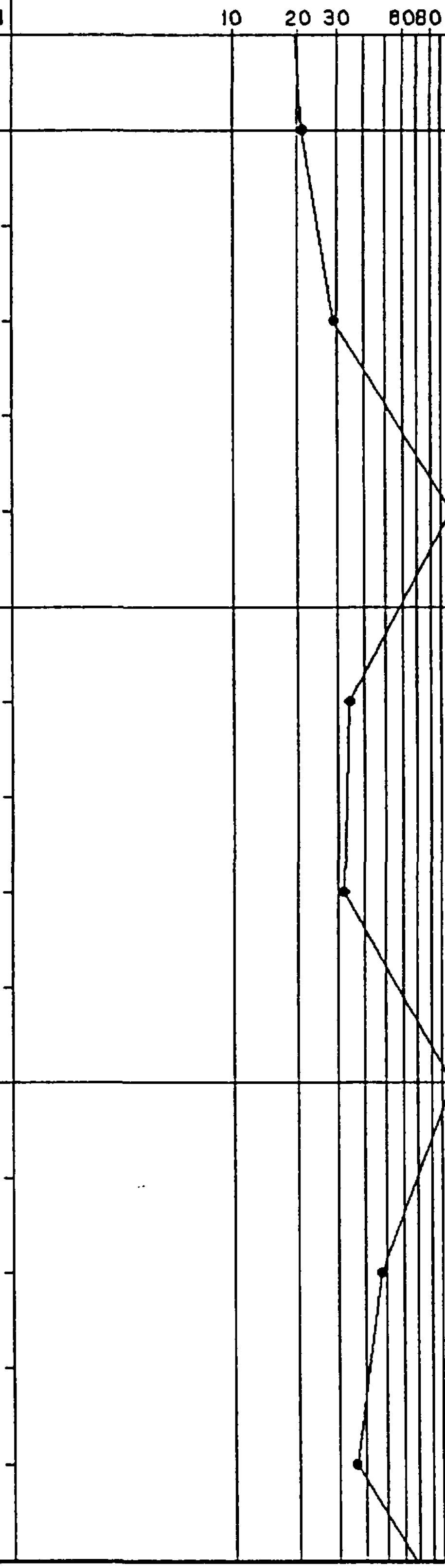
NOTES:
SS = Split Spoon Sample
ND = No Data Available
ST = Shelby Tube Sample
PID background is 0.2 ppm

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio

Project No: 72680.300

LOG OF BORING NO. GW-50

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 883.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
15		2" same, saturated. 4" same, moist, Gley 5/1 with 30% gray mottling. 1" gravel. 11" same, damp.	SS	17	0.4	868.8		21
		Gray (5y 6/1) same, 1% mottling, very stiff, damp.	SS	10	0.5			29
		Same, no mottling, very hard.	SS	1	0.5			100
20						863.8		
			SS	7	0.5			34
			SS	8	0.8			32
25		Dark gray CLAY and SILT, trace limestone chips, slightly plastic, 5% silt, 2% sand, very hard, moist.	SS	13	0.2	858.8		100
		Same with 10% limestone marble sized rounded gravel. 1/4" layer of coarse sand at 27 ft., damp.	SS	23	0.2			47
		Gray (5y 5/1) CLAY, 5% rounded fine to medium gravel, 5% silt, low plasticity, hard, moist.	SS	10	0.8			38



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

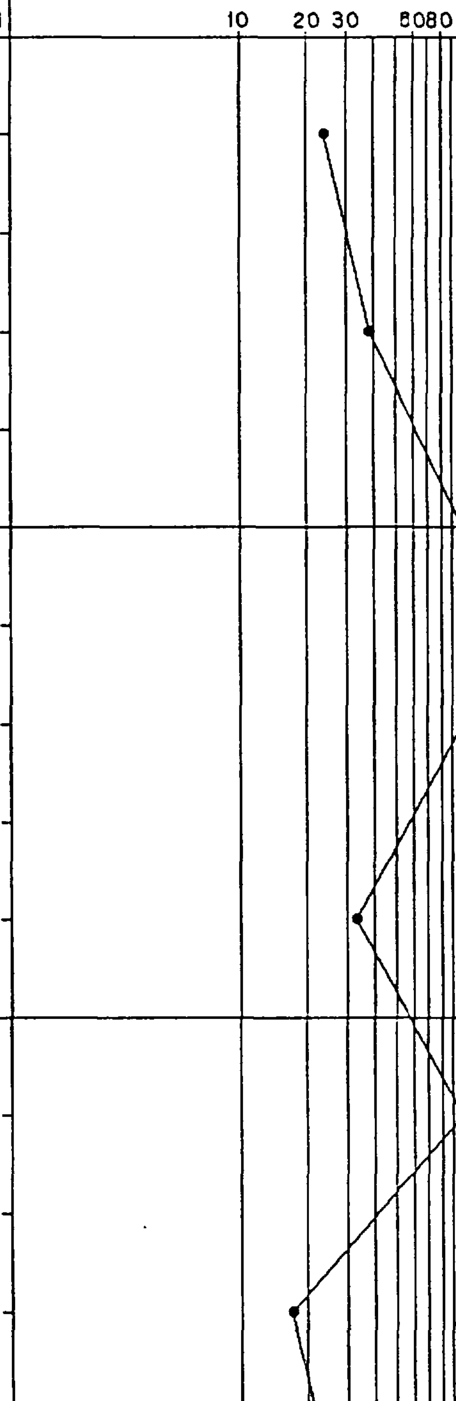
LOG OF BORING NO. GW-50

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 683.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Same.	SS	8	0.8			100
		3" TILL 3" LIMESTONE, top smooth and slightly dripping, bottom smooth. 6" Limestone pebbles. Weathered shale on some surfaces. Bottom 1" shows signs of water staining.	Core	12	ND			
		Boring terminated at 33.4 ft.						
35						648.8		
40						643.8		
45						638.8		

Client: Skinner PRP Group Project: Skinner RDI Location: West Chester, Ohio	Project No: 72680.300	LOG OF BORING NO. GW-51

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	N VALUE
		Light yellowish brown (2.5y 6/4) SILT, 20% angular gravel, 10% sand, very stiff, dry.	SS	8	0.2		24
		Same, hard.	SS	5	1.8		38
5		Same with 30% gravel, very hard.	SS	8	1.8	740.3	100
		No recovery.	SS	NR	ND		100
		Same, hard.	SS	10	1.8		33
10		Same, 50% gravel, very hard.	SS	2	1.8	735.3	100
		Light yellowish brown (2.5y 6/4) well graded SAND, 10% angular gravel, 5% silt, medium dense, dry. (FILL)	SS	5	1.9		17

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-27-94	DATE FINISHED: 10-27-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

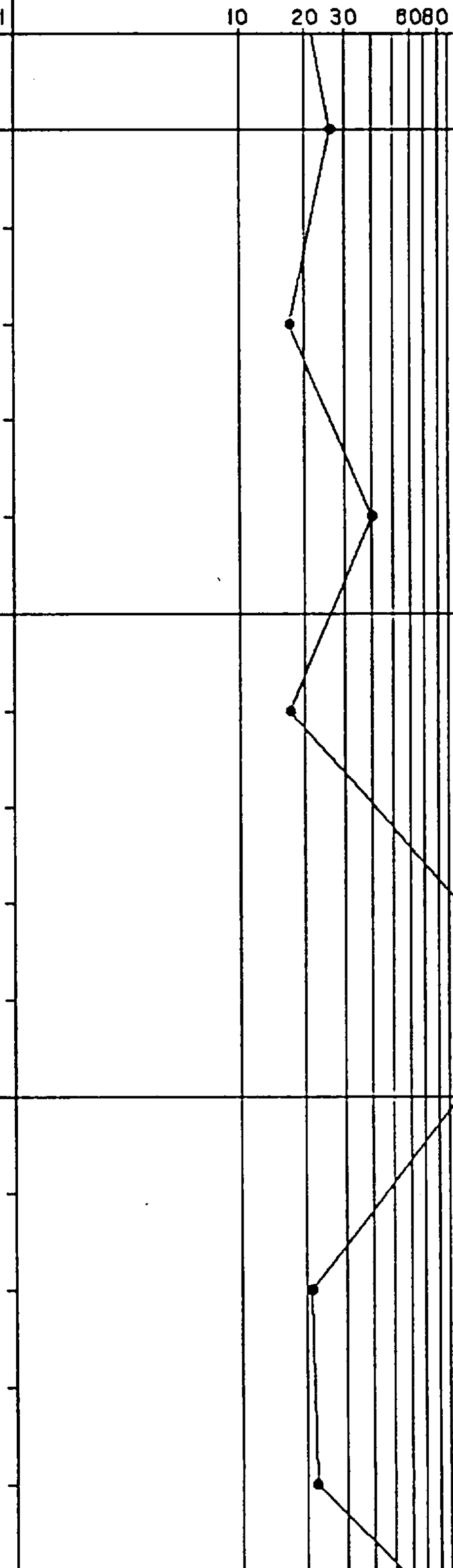
NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
FID background is 2.0 ppm.

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio

Project No: 72680.300

LOG OF BORING NO. GW-51

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
15		Light yellowish brown (2.5y 6/4) SILT, 30% gravel, 5% sand, very stiff, dry.	SS	4	1.8	730.3		28
		Same, 20% gravel, damp.	SS	4	2.0			17
		2" same, 2" limestone rock, damp.	SS	5	1.8			40
20		Yellowish brown (10yr 5/6) SILT, 30% sand, 20% gravel, very stiff, moist. Bag sample taken from 18-22 ft.	SS	7	2.0	725.3		17
		No recovery.	SS	NR	ND			100
25		No recovery.	SS	NR	ND	720.3		100
		Yellowish brown (10yr 5/4) well graded SAND, 10 % gravel, 5% silt, medium dense, damp.	SS	10	1.0			21
		Same. 2" Moist silt with 10% fine sand at 27.2 ft.	SS	10	0.8			22



Client: Skinner PRP Group Project: Skinner RDI Location: West Chester, Ohio Project No: 72680.300	LOG OF BORING NO. GW-51

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Limestone gravel, dry.	SS	2	1.0			100
		Yellowish brown (10yr 5/4) well graded GRAVEL, 30% silt, 20% sand, moist.	SS	3	0.7			28
35		2" Pulverized limestone. 10" Poorly graded, medium to coarse sand, 1% fine gravel, damp.	SS	12	0.8	710.3		31
		No recovery.	SS	NR	ND			100
		1" Limestone gravel, gley (5/5gy) well graded GRAVEL, 30% clay, 10% sand, 10% silt. moist. 2" Well graded SAND, 30% sub-rounded gravel, 5% silt, moist.	SS	13	0.8			38
40		No recovery.	SS	NR	ND	705.3		7
		2" Limestone gravel. 4" Gray (5y 5/1) CLAY, 7% rounded gravel, 5% silt, damp. (TILL)	SS	8	0.4			100
45		Light yellowish brown (2.5y 6/4) CLAY with 5% gray mottling, 20% gravel, 5% silt, 5% sand inseams, low plasticity, hard, moist.	SS	8	2.5	700.3		38

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

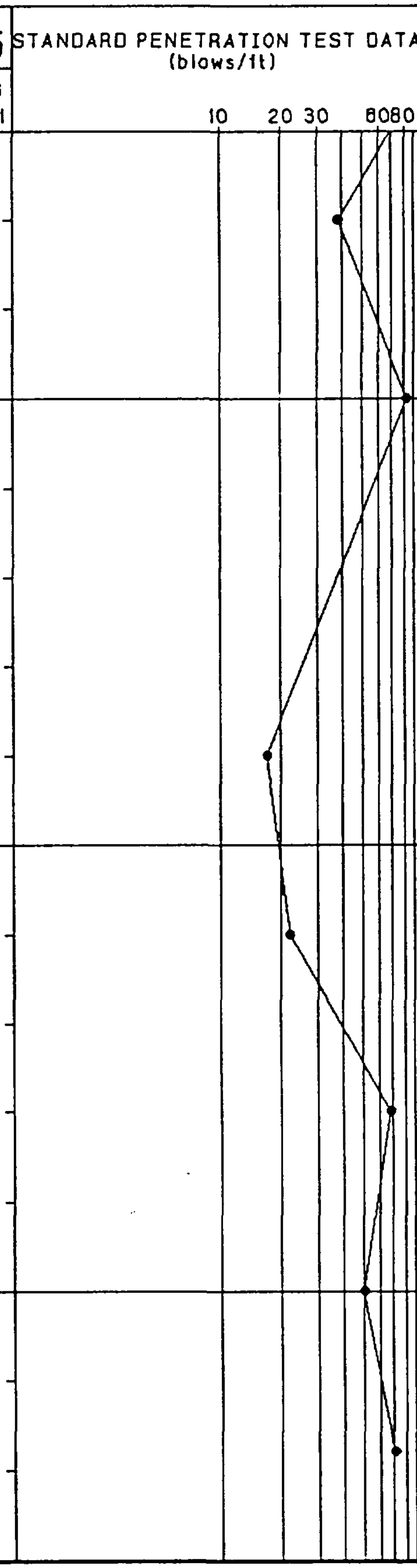
LOG OF BORING NO. GW-51

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		7" Gray (2.5y 5/1) poorly graded fine SAND, 40% silt, 2% rounded gravel, wet. 8" Gray (2.5y 5/1) CLAY, 5% rounded gravel, 5% silt, medium plasticity, wet.	SS	15	10			?
		6" Gray (2.5y 5/1) and light yellowish brown (2.5y 6/4) mottled, same, damp.	SS	8	8.5			38
50		Light yellowish brown (2.5y 6/3), poorly graded, medium SAND, damp. Light brownish gray (2.5y 6/2) well graded SAND, 10% rounded gravel, 5% silt, damp.	SS	5	8.2	695.3		100
		1" Limestone 11" Light olive brown (2.5y 5/3) poorly graded, fine SAND, 10% silt, 5% gravel, wet.	SS	12	50.2			32
55		Grayish brown (2.5y 5/2), poorly graded, medium to coarse SAND, 2% gravel, wet.	SS	8	280	690.3		32
		Same, saturated.	SS	8	300			52
		15" Light brownish gray (2.5y 6/2) well graded SAND, 20% silt, 10% gravel, saturated. 9" Gray (2.5y 5/1) well graded SAND, saturated.	SS	24	30			38
60		2" Same. 3" Gray (2.5y 5/1) CLAY, 10% gravel, moist. (TILL)	SS	7	100	685.3		100

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-51

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	N VALUE
	Gray (2.5y 5/1) poorly graded, coarse to very coarse, rounded SAND, 10% rounded gravel, 5% clay. Clayey layers (30% clay) at 62.8 and 63.5 ft., saturated. Bottom 4" CLAY with 10% gravel, medium plasticity, moist. (TILL)	SS	24	8		38
65	Light olive brown (2.5y 5/4) same, 5% gray mottles, moist.	SS	5	12	680.3	83
		NS	NS	ND		ND
	Very coarse SAND with 5% fine rounded gravel, grades to poorly graded GRAVEL with 20% sand, saturated.	SS	10	2.8		17
70	Gray (5y 5/1) CLAY, 10% rounded gravel, 10% coarse sand, damp. (TILL)	SS	4	7.2	675.3	22
	Same, damp.	SS	8	13		68
75	Same with 3% rounded gravel, high plasticity, damp. (TILL)	SS	5	8.5	670.3	50
	Same, moist.	SS	3	29		71
	Crushed LIMESTONE. Some of the pieces show mineral staining.	Core	8	ND		



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-51

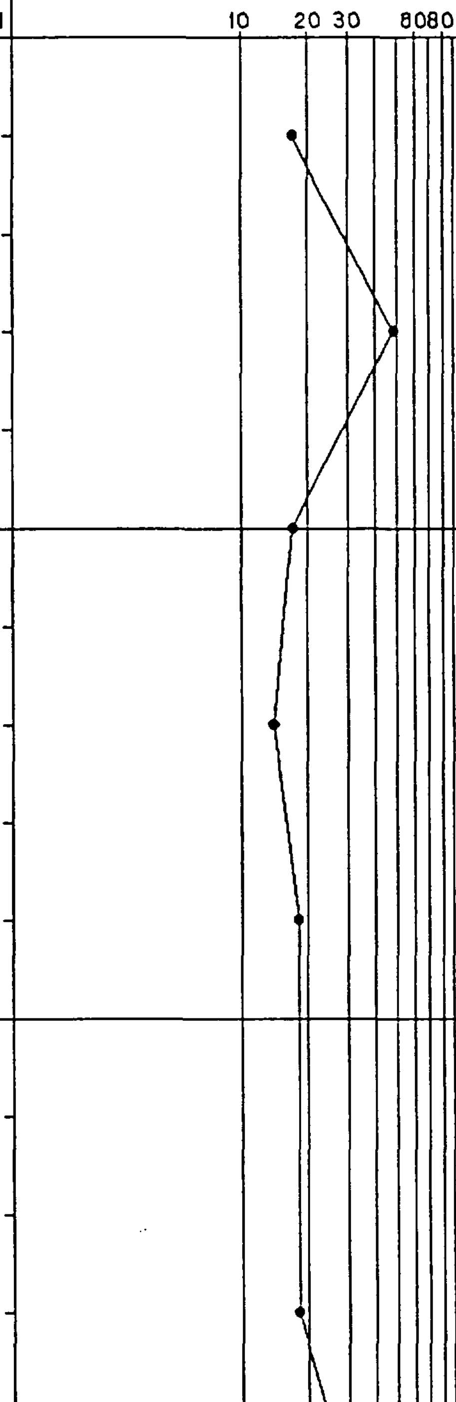
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 745.3 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
			Core	6	ND			ND
		Boring terminated at 79.2 ft.						
80						665.3		
85						660.3		
90						655.3		

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. GW-52

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	FID (ppm)	ELEV. (MSL) 686.3 (ft.)	N VALUE
	Dark grayish brown (10yr 4/2) SILT, 10% fine sand, 10% clay, organic matter, damp.	SS	3	0.1		17
	Yellowish brown (10yr 5/8) poorly graded, fine to medium SAND, 40% gravel, 10% silt, dry.	SS	10	0.1		48
5	5" Same. 4" Dark gray SILT, 10% clay, 5% sand, 5% fine gravel, moist.	SS	9	ND	681.3	17
	Dark gray (5y 4/1) poorly graded, fine to medium SAND, 40% gravel, 20% silt, moist. Bag sample taken from 6-8 ft.	SS	4	0.1		14
	Gley (5/5gy) CLAY, 20% silt, 5% fine to medium rounded gravel, low sphericity, 5% black laminae, high plasticity, moist. (TILL) Bag sample taken from 8-10 ft.	SS	8	0.1		18
10	No recovery.	ST	NR	ND	676.3	
	Same.	SS	12	1.8		18

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-13-94	DATE FINISHED: 10-13-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
ST = Shelby Tube Sample
FID background is 1.0 ppm

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-52

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	FID (ppm)	ELEV. (MSL) 886.3 (ft.)	N VALUE
15	Same, with no laminae, 2% orange mottling, damp.	SS	5	5.0	871.3	30
	Same with very thin sand seam at 17.6 ft., damp.	SS	9	1.8		30
	Gley (5/10y) CLAY, 30% silt, 5% fine to medium gravel, rounded, spherical, high plasticity, dry. Bag sample taken from 18–20 ft. (TILL)	SS	11	5.5		40
20	Same.	SS	11	4.0	866.3	48
	Same with very thin sand seam at 23.5 ft.	SS	13	11		45
25	Same, damp.	SS	15	4	861.3	29
	Same, no mottling, damp.	SS	6	0.2		66
	HQ rock coring begins at 27.4 ft. No recovery.	CORE	NR	ND		
	Boring terminated at 29.4 ft.					

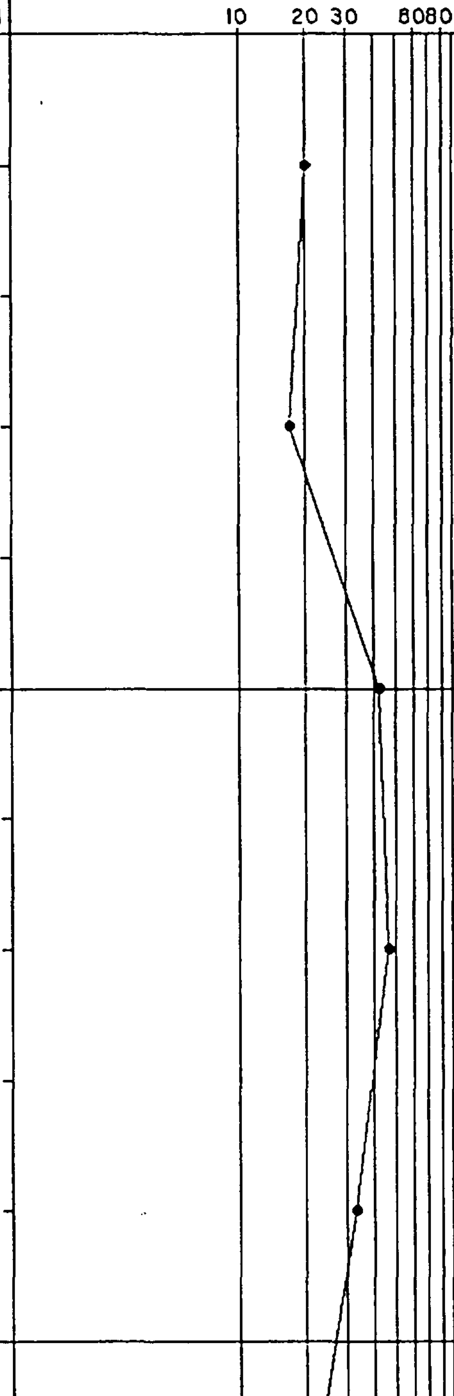
STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. GW-53

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 885.2 (ft.)	N VALUE
		Brown (10yr 4/3) grades to black SILT with 30% fine to course gravel, 20% fine to course sand, very stiff, dry.	SS	8	0.3		20
		Same, damp.	SS	6	0.4		17
5		Light gray (10yr 7/1) poorly graded GRAVEL, 10% sand, 5% silt, very hard, damp to moist. Gravel angular with low sphericity.	SS	7	0.4	880.2	42
		3" Dark gray (5y 5/3) SILT with 30% gravel, 20% sand, very hard, wet. (TILL) 7" Olive (5y 5/3) SILT with 5% sand and 5% fine to medium gravel. very hard, moist. (TILL)	SS	10	0.3		48
		No recovery.	SS	NR	ND		33
10		Same as 7.3 ft to 8 ft. with pale olive (5y 6/3) mottling, moist.	SS	4	0.8	875.2	

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-11-94
DATE FINISHED: 10-11-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger
GEOLOGIST: S. Poole
DRILLER: J. Murphy
WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
PID background is 0.3 ppm.

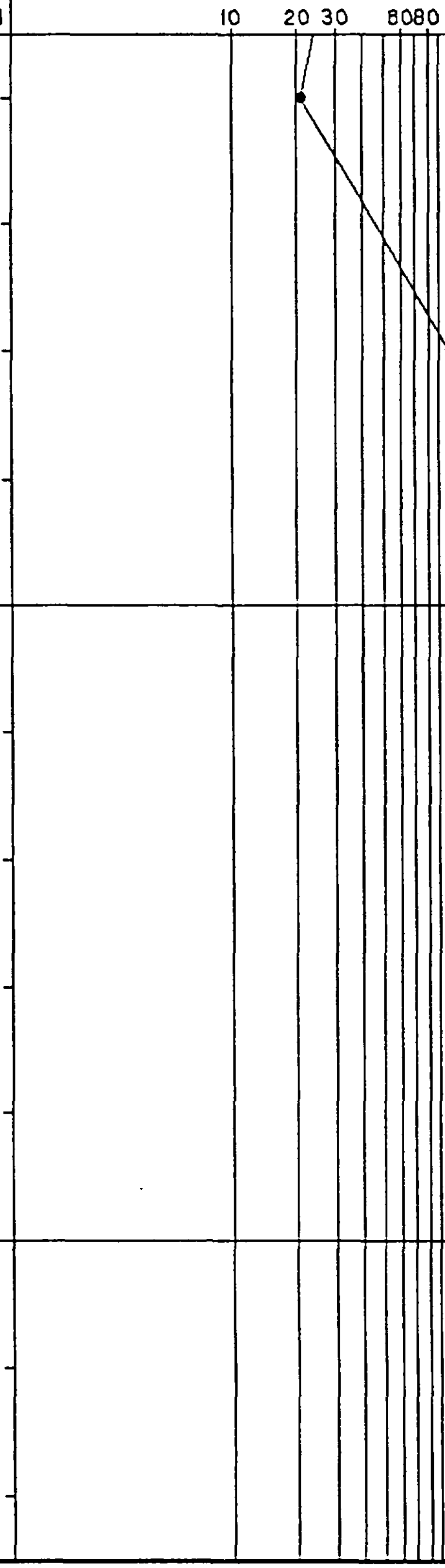
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio	Project No: 72680.300

LOG OF BORING NO. GW-53

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 885.2 (ft.)	N VALUE
			SS	4	0.8		21
		Same, damp. Gravel highly rounded with low sphericity. (TILL)	SS	7	0.8		
		HQ rock coring begins at 12.75 ft. 1.5" Fossilferous LIMESTONE. Bottom bedding smooth. 0.1" Gray clay. 7" Fossilferous limestone. Top bedding surface smooth and slightly dipping. Fractures at 4.5", 5.5", 6". 8" Pale olive (5y 6/4) SILT, 10% clay, 15% fine to medium gravel, 10% sand. 3" Interbedded limestone and weathered shale. 3" Fossilferous limestone.	CORE	23	0.8		100
15						870.2	
		Boring terminated at 14.6 ft.					
20						865.2	

STANDARD PENETRATION TEST DATA (blows/ft)



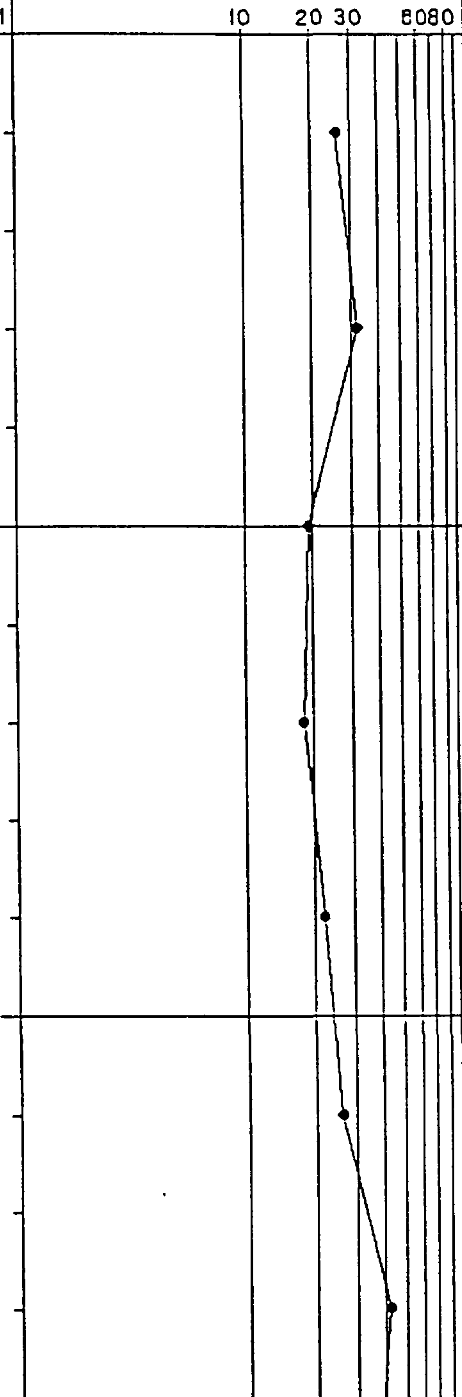
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-54

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 889.3 (ft.)	N VALUE
	3" Dark grayish brown (10yr 4/2) SILT,with 20% fine to medium gravel, very stiff, dry. 7" Light gray well graded, fine to medium SAND, 40% fine to coarse gravel, 5% silt, dry. Gravel is angular with medium sphericity.	SS	10	0.2		28
	3" Well graded gravel, limestone. 3" Dark yellowish brown (10yr 4/4) well graded SAND, 30% fine to medium gravel, rounded, high spericity, 10% silt, hard, moist. 2" crushed pebble, dry.	SS	8	0.2		32
5	Few pieces of gravel and coarse sand, saturated.	SS	<.5	0.2	884.3	18
	5" Gray (10yr 5/1) SILT with 5% fine gravel, low plasticity, moist. 5" Poorly graded fine sand with slight black staining, very stiff, moist.	SS	10	0.3		18
	3" Gray (10yr 5/1) SILT with 20% fine sand and 10% fine gravel, very stiff, damp. (TILL) 3" Olive (5Y 5/3) CLAY with 2 thin interbeds of medium sand, damp. (TILL)	SS	8	0.2		22
10	3" Dark gray (5y 4/1) well graded, fine to medium gravel, moist. 3" Dark gray (5y 4/1) SILT, 20% sand, 10% fine to medium gravel, very stiff, damp. (TILL)	SS	8	0.2	879.3	28
	Dark gray (5y 4/1) SILT, 10% sand 10% fine to medium gravel, dry. (TILL)	SS	5	0.2		42

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-12-94 DATE FINISHED: 10-12-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core
GEOLOGIST: S. Poole DRILLER: J. Murphy
WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
ND = No Data Available
ST = Shelby Tube Sample
PID background is 0.2 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-54

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 889.3 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Same.						
15			SS	12	0.2	874.3		38
		Same, dry.	ST	4	ND			
			SS	18	0.2			47
20						869.3		
			SS	10	0.2			31
		Olive (5y 5/3) CLAY, medium plasticity, dry. (weathered shale)	SS	8	0.2			100
		Auger refusal at 22.5 ft. HQ rock coring begins at 22.5 ft. 7" Crushed limestone. 2" Weathered shale, moist. Olive with 10% mottling. 2" Limestone 2" Weathered shale, mottling in fractures. 1" Limestone, iron staining in fractures.	CORE	14	ND			
25						864.3		
		Boring terminated at 24.5 ft.						

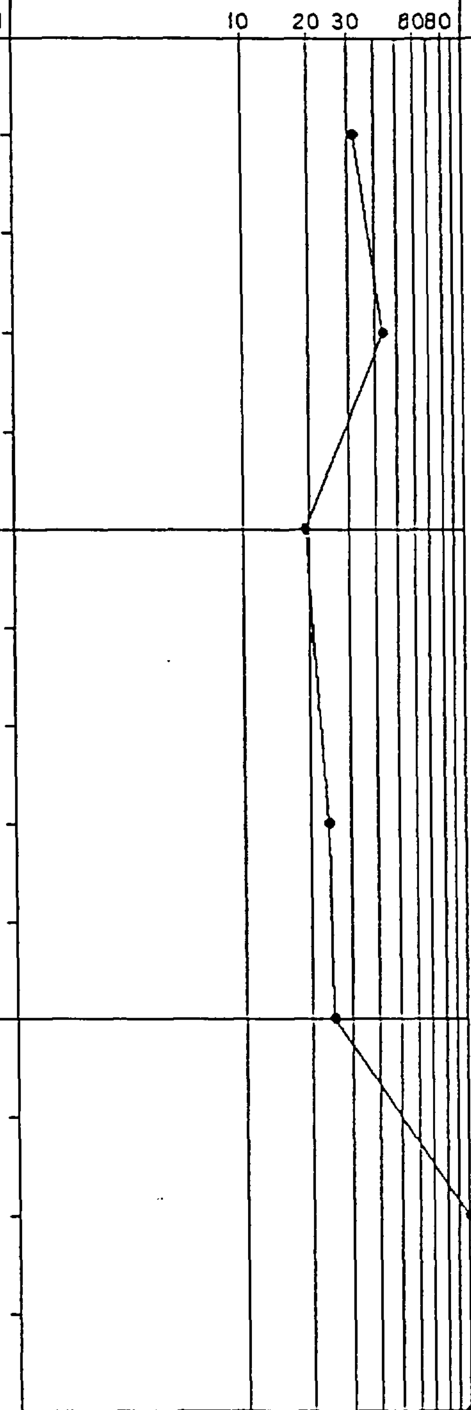
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. GW-55

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 698.4 (ft.)	N VALUE
	2" Dark yellowish brown (10yr 4/4) SILT with 20% sand, 20% fine gravel, hard, dry. 2" Limestone, crushed. 4" Same as top, dry.	SS	8	0.0		32
	Dark yellowish brown (10yr 3/4) SILT with 50% fine to large gravel, very hard, dry.	SS	10	0.0		43
5	Yellowish brown (10yr 5/6) SILT with 5% fine gravel, slightly plastic, very stiff, dry.	SS	8	0.0	693.4	19
	Shelby tube description from bottom of tube is the same as above with 10% gray mottling, dry.	ST	3	ND		
	Pale olive (5y 6/3) with 10% gray mottling CLAY with 20% silt, 5% fine gravel, very stiff, dry. (TILL)	SS	11	0.2		24
10	Yellowish brown (10yr 5/6) and Pale olive (5y 6/3) SILT with 80% limestone cobbles.	SS	3	0.2	688.4	25
	Light yellowish brown (2.5y 6/4) SILT with 10% fine to medium gravel, very hard, dry.	SS	0.5	0.8		100
	Auger refusal at 14.15 ft. HQ rock coring begins at 14.15.	SS	NR	ND		100

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-10-94
DATE FINISHED: 10-10-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core
GEOLOGIST: S. Poole
DRILLER: J. Murphy
WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
ST = Shelby Tube Sample
NR = No Recovery
ND = No Data Available
PID background is 0.8 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. GW-55

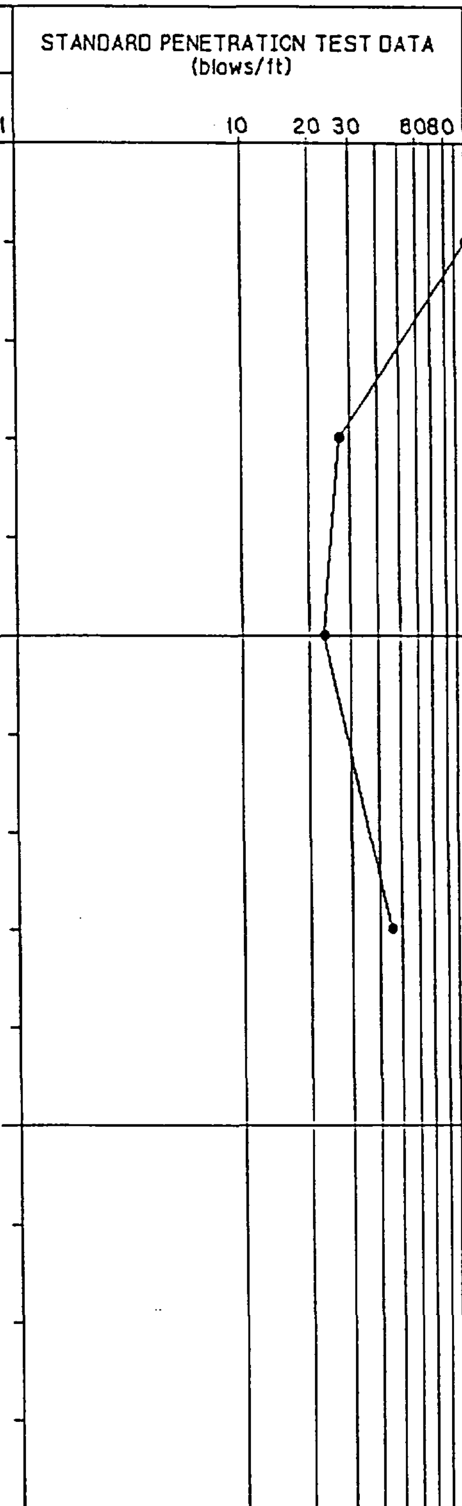
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 898.4 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
			SS	NR	ND			
15		Top 2.5" of core is crushed limestone. Bottom 3.5" is fossilferous gray limestone.	Core	6	1.0	883.4		
		Boring terminated at 15.8 ft.						
20						878.4		
25						873.4		

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner ROI
Location: West Chester, Ohio Project No: 72880.300

LOG OF BORING NO. GW-56

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 899.5 (ft.)	N VALUE
	Brown (10yr 5/3) SILT, dry, powdery, 5% organic material.	SS	5	0.8		100
	Same, Limestone last 2",dry.	SS	7	1.4		27
5	Dark yellowish brown (10yr 3/4) SILT with 30% organic materials (sticks, leaves, roots), dry. Bottom 4" light gray limestone.	SS	8	1.8	894.5	23
	Dark yellowish brown (10yr 4/4) SILT with 10% fine to coarse gravel, dry.	ST	2	ND		
	1" Light olive gray (5y 6/2) CLAY with 10% fine to medium gravel, and 2% sand with gray mottles, high plasticity, damp. Bag sample taken from 6-9 ft.	SS	8	0.8		45
10	Auger refusal at 9 ft. Begin HQ coring. 12" Fossilferous LIMESTONE with bedding planes every 0.5 to 3 inches. Bedding surfaces separated by thin layers of weathered shale. 3" Gray weathered shale. 2" Limestone.	CORE	17	0.8	889.5	
	Boring terminated at 11.0 ft.					



DATE STARTED: 10-10-94	DATE FINISHED: 10-10-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
ST = Shelby Tube Sample
ND = No Data Available
PID background is 0.4 ppm.

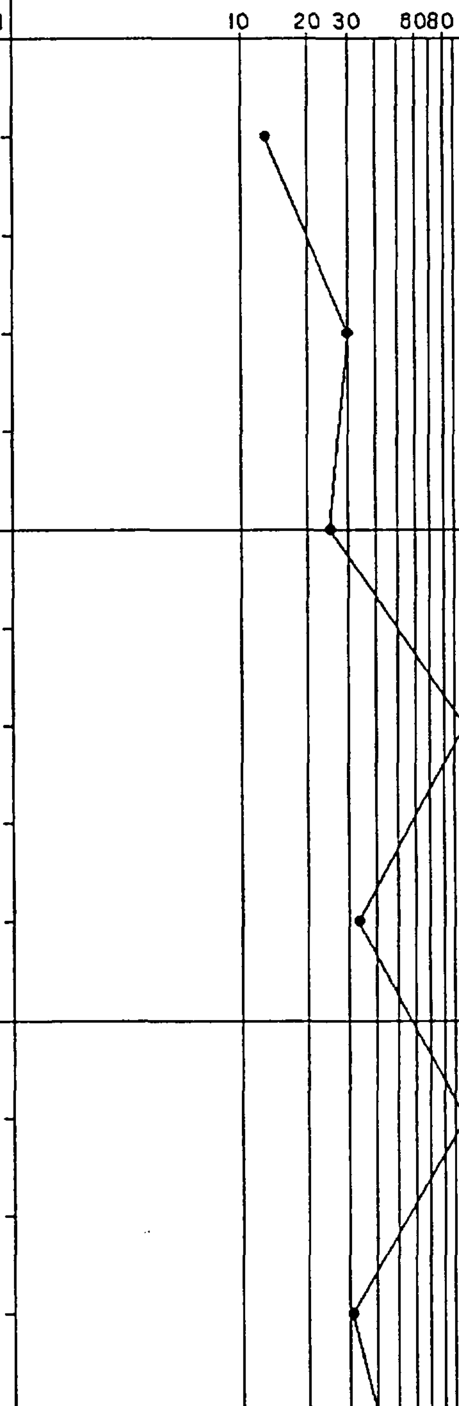
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. GW-57

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 704.8 (ft.)	N VALUE
		Brown (10yr 4/3) SILT, stiff, dry.	SS	10	2.0		13
		Dark brown (10yr 3/3) SILT with trace gravel, very stiff, dry.	SS	8	2.8		30
5		Brown (10yr 5/3) SILT, very stiff, dry.	SS	12	1.8	699.8	25
		Limestone gravel.	SS	4	1.8		100
		Grayish brown (2.5y 5/2) CLAY, hard, dry.	SS	8	1.8		33
10		Grayish brown (2.5y 5/2) and gray (2.5y 6/1) mottled SILT, very hard, moist. Bag sample taken from drill cuttings.	SS	0.5	1.8	694.8	100
		No recovery	SS	NR	NS		31

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-5-94	DATE FINISHED: 10-5-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
PID background is 1.8 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. GW-57

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 704.6 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		7" Light gray (2.5y 7/2) SILT with some sand, hard, saturated. 5" Limestone.	SS	12	1.8			
15						689.6		49
		Auger refusal at 15 ft. Begin HQ coring. 8" Crushed LIMESTONE. 4" Limestone. 1/4" Weathered shale. 2" Limestone. 4" Weathered shale. 3" Limestone. Bedding planes smooth.	Core	22	ND			
		Boring terminated at 17 ft.						
20						684.6		
25						679.6		

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio

Project No: 72880.300

LOG OF BORING NO. B-59

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 734.5 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) N VALUE
	Light yellowish brown SILT, 30% sand, 10% clay, trace gravel, non-plastic, very stiff, damp. (FILL)	SS	18	BG		28
	Light yellowish brown SILT, 20% clay, 10% sand, trace gravel, limestone, non-plastic, very stiff, damp. (FILL)	SS	18	BG		28
5	Light yellowish brown CLAY, 20% silt, 10% sand, plastic, very stiff, moist. (FILL)	SS	12	BG	729.5	21
	Same.	SS	12	BG		26
	Same, stiff.	SS	15	BG		15
10	Light yellowish brown fine SAND, 15% silt, 15% clay, non-plastic, stiff, wet.				724.5	
	Gray CLAY, 10% silt, 10% sand with limestone fragments, plastic, very stiff, moist.	SS	8	BG		17
	Same, very hard.	SS	4	BG		100

DATE STARTED: 10-21-94

DATE FINISHED: 10-21-94

DRILLING METHOD: 4-1/4" ID Hollow Stem Auger

GEOLOGIST: F. Eichler

DRILLER: D. Roelker

WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
BG = Background
PID background is 0.8 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio

Project No: 72680.300

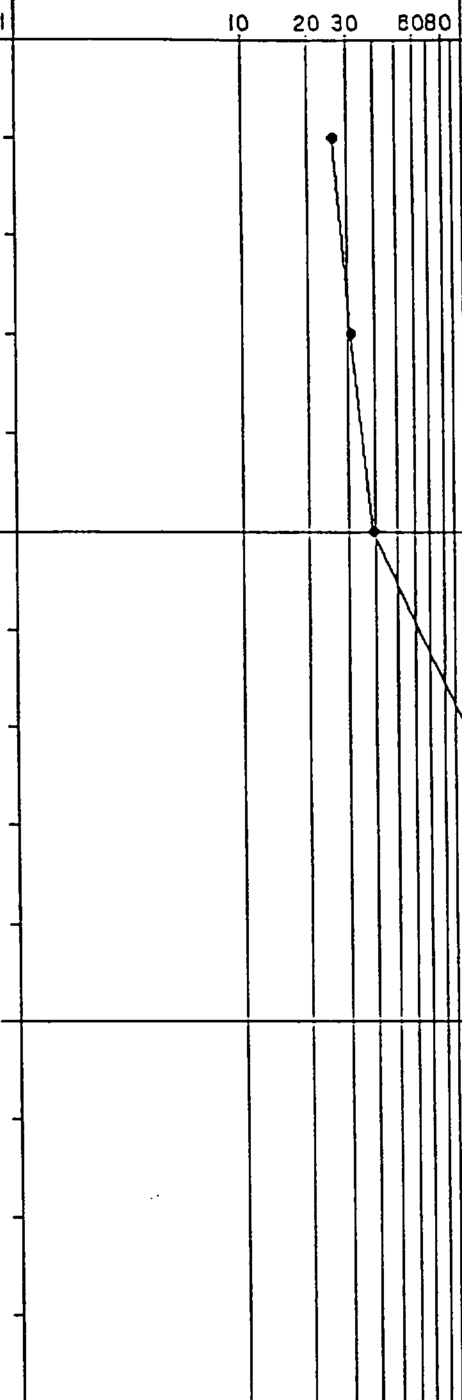
LOG OF BORING NO. B-59

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 734.5 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
15		Gray CLAY, 10% silt with limestone fragments, plastic, very stiff, moist. Weathered shale and fossiliferous limestone fragments.	SS	4	BG	719.5		25
		Auger refusal at 16 ft. Boring terminated at 16 ft.	SS	NR	ND			100
20						714.5		
25						709.5		

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-60

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 728.5 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
		Light yellowish brown CLAY, 20% silt with trace gravel, very stiff, plastic, moist. (FILL)	SS	12	BG			28
		Light yellowish brown CLAY, 20% silt with trace gravel, hard, plastic, moist. (FILL)	SS	18	BG			31
5		Light brown CLAY, 10% silt and sand with limestone fragments, plastic, hard, moist. (FILL)	SS	15	BG	723.5		38
		Bottom 2" Light yellowish brown fine SAND, non-plastic, wet. Brown SAND, 20% clay, 20% silt, non-plastic, very stiff, saturated.	SS	1	1.0			100
		Boring terminated at 8 ft.						
10						718.5		



DATE STARTED: 10-21-94	DATE FINISHED: 10-21-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: F. Eichler	DRILLER: D. Roelker
WATER LEVEL: --	

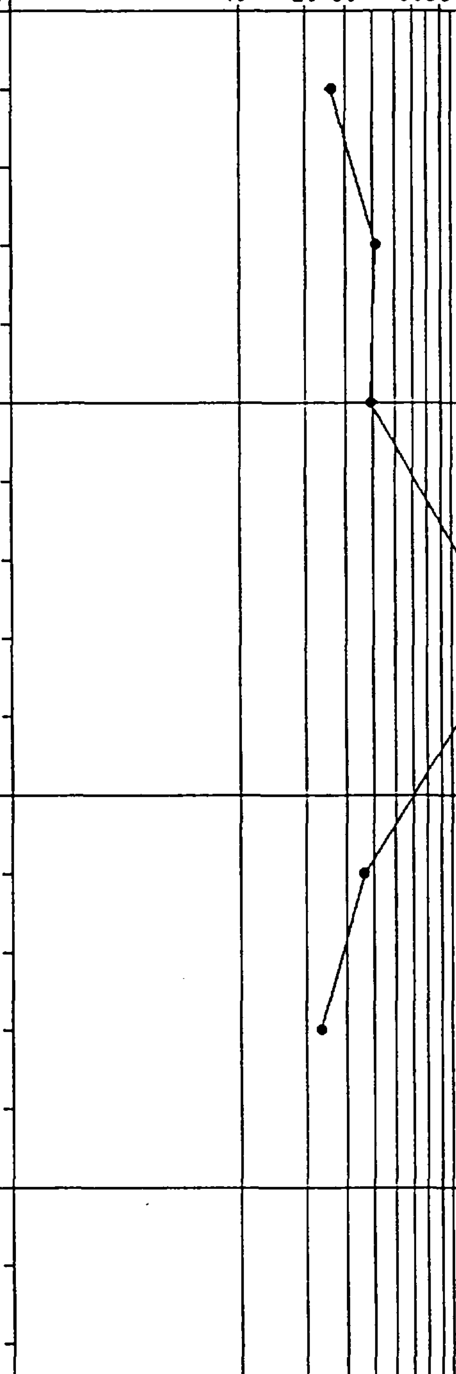
NOTES:
SS = Split Spoon Sample
BG = Background
PID background is 0.8 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio — Project No: 72880.300

LOG OF BORING NO. B-61

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 734.2 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Brown CLAY, 20% silt and limestone fragments, plastic, very stiff, moist. (FILL)	SS	15	BG			28
		Pale brown SILT, 50% limestone fragments, 30% clay, non-plastic, hard, dry. (FILL)	SS	10	BG			41
5		Pale yellow CLAY, 50% limestone fragments, 20% silt, plastic, hard, dry. (FILL)	SS	8	BG	729.2		39
		Limestone rock fragments with trace fine sand and silt. (FILL)	SS	2	BG			100
		Limestone rock fragments. (FILL)	SS	4	BG			100
10		Limestone rock fragments, some fossiliferous. (FILL)	SS	8	BG	724.2		38
		Light yellowish brown fine to medium SAND, 10% silt, very stiff, non-plastic, saturated.	SS	8	BG			23
15		Boring terminated at 14 ft.				719.2		



DATE STARTED: 10-21-94	DATE FINISHED: 10-21-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: F. Eichler	DRILLER: D. Roelker
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
BG = Background
PID background is 0.8 ppm.

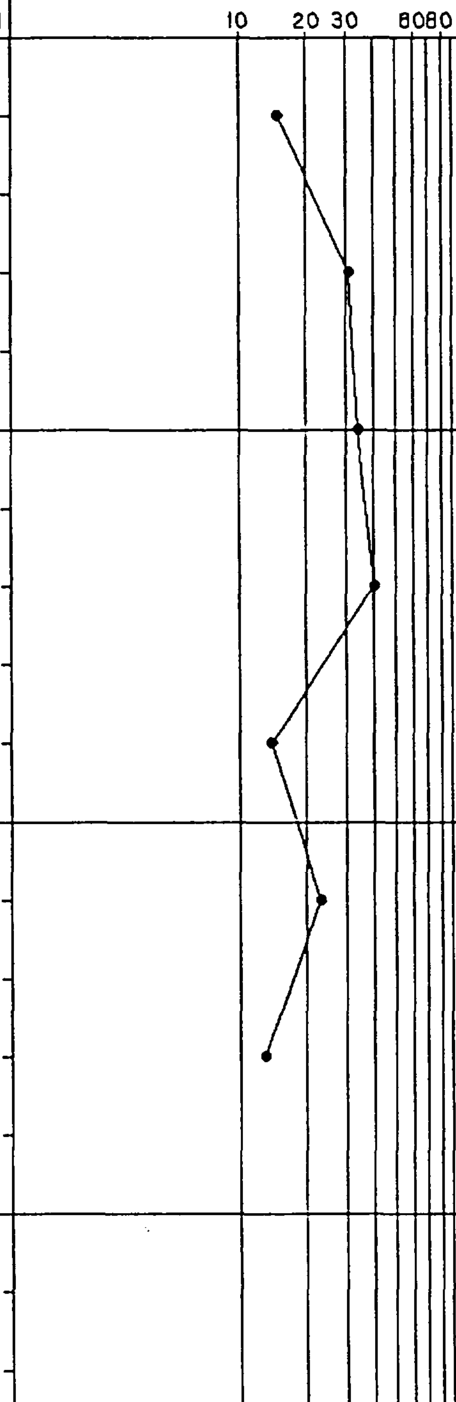
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-62

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 730.2 (ft.)	N VALUE
	2" Dark brown CLAY, 30% silt, 10% fine gravel, moist. 2" Yellow brown, poorly graded GRAVEL, 20% silt, 20% sand, damp. 14" Pale yellow, poorly graded sand, dry.	SS	18	1.0		15
	Yellow gray, well graded SAND, 40% gravel, 10% silt, hard, dry. Gravel angular. Bag sample taken from 4-8 ft.	SS	12	1.0		31
5		SS	8	1.0	725.2	34
	Yellow gray, well graded SAND, 30% gravel, 15% silt, hard, dry. No recovery.	SS	NR	ND		40
	Yellow brown CLAY, 40% SAND, 10% fine gravel, 5% silt, stiff, damp.	SS	8	1.3		14
10	11" Well graded angular gravel, 20% sand, 5% silt, very stiff, dry. 1" Black CLAY, 20% sand, moist.	SS	12	1.0	720.2	23
	4" Olive with black mottles, poorly graded SAND with 30% gravel, 5% silt, saturated. 4" Same, olive, moist.	SS	10	1.0		13
	Boring terminated at 14 ft.					
15					715.2	

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-20-94	DATE FINISHED: 10-20-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
NR = No Recovery
ND = No Data Available
PID background is 1.0 ppm.

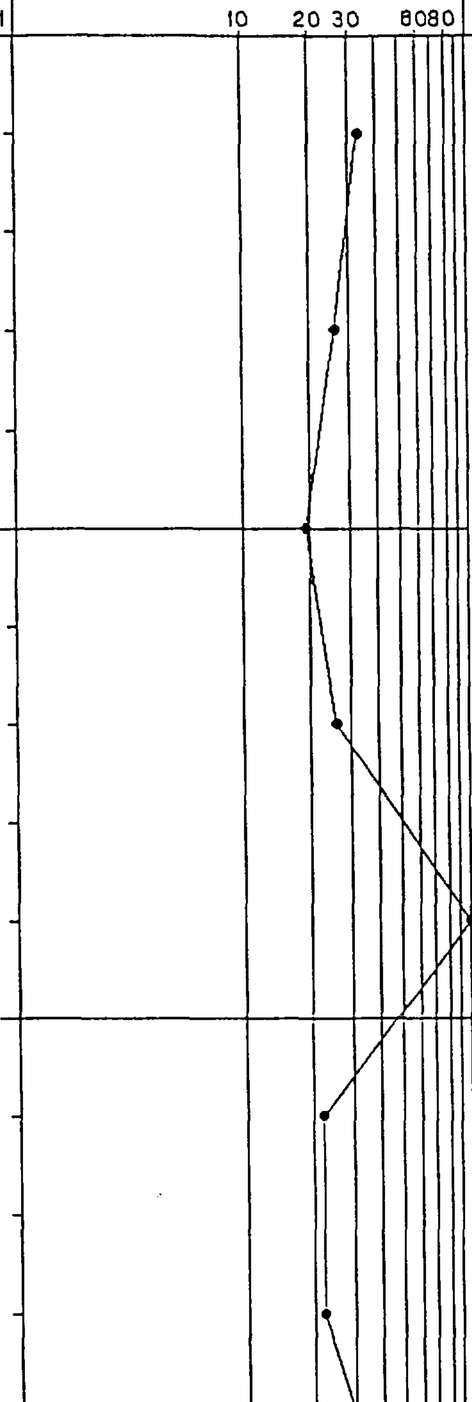
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio　　Project No: 72680.300

LOG OF BORING NO. B-63

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 732.2 (ft.)	N VALUE
	2" Organic SILT, dry. 10" Light olive brown (2.5y 5/3) CLAY, 30% silt, hard, dry.	SS	12	0.4		33
	Pale yellow (2.5y 7/3) SILT, non-plastic, very stiff, dry.	SS	14	0.4		28
5	Same with iron stains and laminae.	SS	8	0.4	727.2	19
	Pale yellow (2.5y 7/3) SILT, trace fine sand, non-plastic, very stiff, dry.	SS	8	0.4		28
	Gray limestone with hoizontal partings between 1/4" thick pieces. Rock at 9.5 ft.	SS	10	0.4		100
10	2" Yellow brown SILT, dry. 2" Pulverized limestone, dry. Very stiff.	SS	4	1.2	722.2	22
	Crushed rock, very stiff, dry.	SS	2	1.0		22

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-18-94	DATE FINISHED: 10-18-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
PID background is 0.4 ppm.

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-63

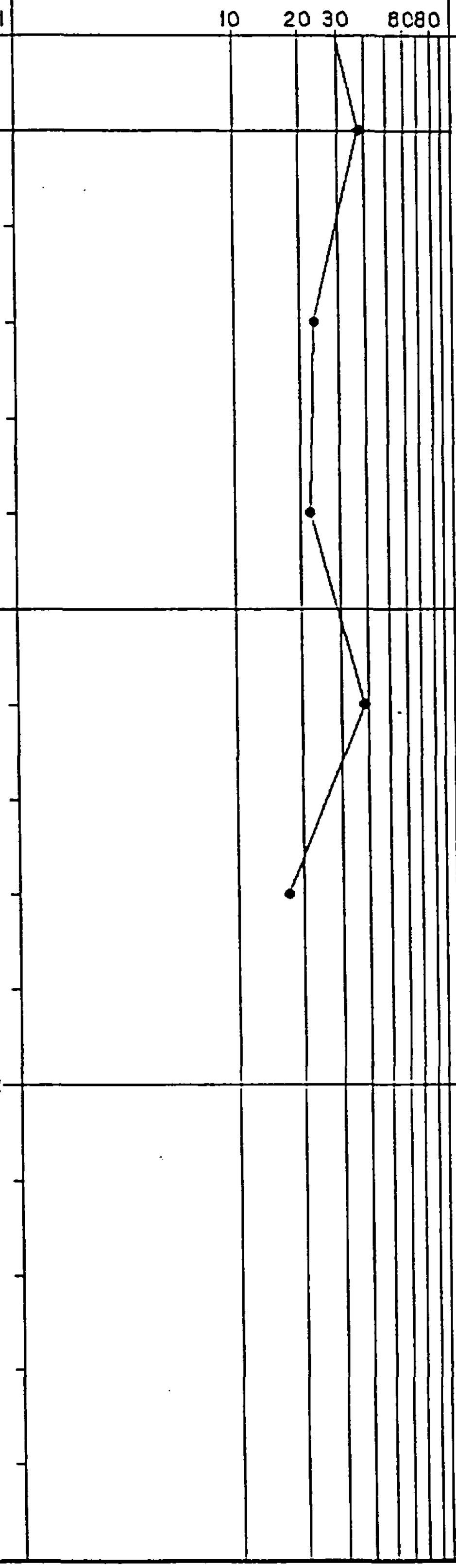
DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 732.2 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) N VALUE
15	Light greenish gray, well graded SAND, 20% fine to medium gravel, hard, damp.	SS	4	2.8	717.2	37
	Olive SILT with 2% rounded gravel, strange odor, non-plastic, very stiff, moist. (TILL)	SS	4	2.2		23
	4" Greenish gray SILT, 20% clay, 10% sand, 5% rounded gravel, very stiff, moist. (TILL) 2" Same, yellow, damp.	SS	8	1.4		22
20					712.2	
	Olive, grades to black, well graded SAND, 30% gravel, 20% silt, non-plastic, hard, moist to wet.	SS	8	1.0		38
	Same with free product, saturated, black, water below the free product.	SS	10	35		17
	Boring terminated at 24 ft.					
25					707.2	

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio — Project No: 72680.300

LOG OF BORING NO. B-63

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 732.2 (ft.)	N VALUE
15	Light greenish gray, well graded SAND, 20% fine to medium gravel, hard, damp.	SS	4	2.8	717.2	37
	Olive SILT with 2% rounded gravel, strange odor, non-plastic, very stiff, moist. (TILL)	SS	4	2.2		23
	4" Greenish gray SILT, 20% clay, 10% sand, 5% rounded gravel, very stiff, moist. (TILL) 2" Same, yellow, damp.	SS	8	1.4		22
20	Olive, grades to black, well graded SAND, 30% gravel, 20% silt, non-plastic, hard, moist to wet.	SS	8	1.0	712.2	38
	Same with free product, saturated, black, water below the free product.	SS	10	35		17
	Boring terminated at 24 ft.					
25					707.2	

STANDARD PENETRATION TEST DATA (blows/ft)

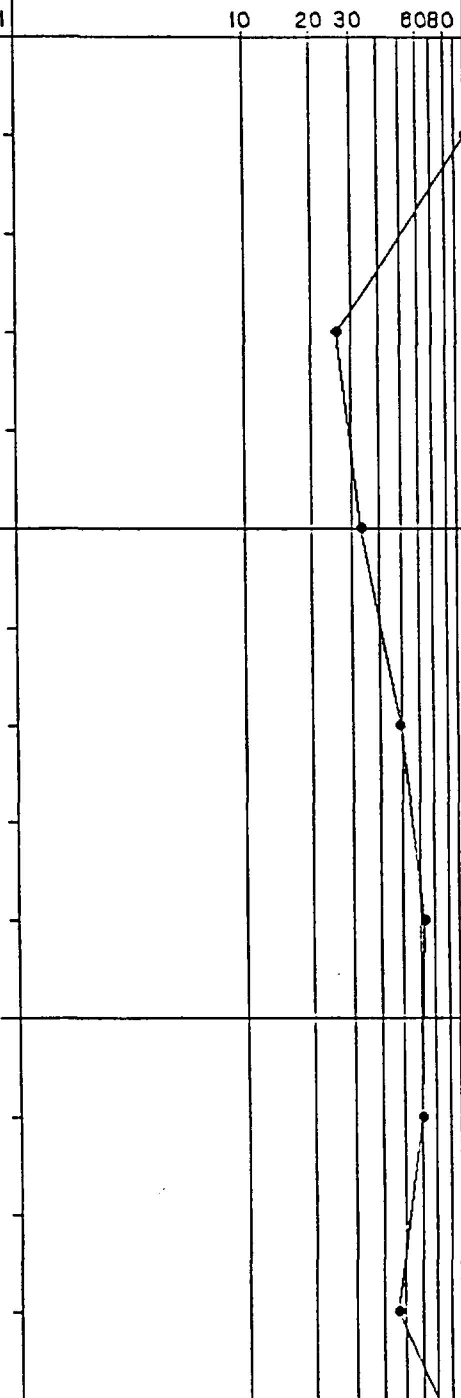


Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-64

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 733.4 (ft.)	N VALUE
	Brown CLAY, 20% silt, rock fragments (FILL), plastic, very hard, moist.	SS	8	BG		100
	Brown CLAY, 15% silt, rock fragments (FILL), plastic, very stiff, damp.	SS	10	BG		28
5	Same, hard.	SS	8	BG	728.4	33
	Same.	SS	12	BG		49
	Pale yellow CLAY, 25% silt, rock fragments (FILL & bedrock), non-plastic, very hard, dry.	SS	15	BG		83
10	Limestone fragments with pale yellow CLAY, 25% silt, non-plastic, very hard, dry.	SS	8	BG	723.4	80
	Limestone fragments with some pale yellow clay, 30% silt, plastic, hard, damp.	SS	8	BG		48

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-20-94	DATE FINISHED: 10-20-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: F. Eichler	DRILLER: D. Roelker
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
ND = No Data Available
BG = PID background is 0.8 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-64

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 733.4 (ft.)	N VALUE
15	Limestone fragments with clay mixed. Drilling through random limestone, silt, and clay.	SS	2	BG	718.4	100
	Pale yellow SILT, 10% clay, 15%, sand and limestone fragments, non-plastic, hard, moist.	SS	12	BG		48
	Pale yellow CLAY, 20% silt with limestone fragments (FILL), plastic, hard, moist.	SS	12	BG		40
20	Brown CLAY, 15% silt with limestone fragments, plastic, hard, damp.	SS	4	BG	713.4	43
	Gray, fine to medium SAND with trace limestone gravel, non-plastic, hard, dry.	SS	15	BG		45
25	Same.	SS	15	BG	708.4	34
	Gray, fine to medium SAND, 30% fine gravel, 10% silt, non-plastic, very stiff, dry.	SS	4	BG		30
	Gray, fine to medium SAND, 30% fine gravel, non-plastic, hard, dry.	SS	8	BG		34

STANDARD PENETRATION TEST DATA (blows/ft): 10 20 30 6080

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-64

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 733.4 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		Dark gray, fine to course SAND, 25% silt, 10% fine gravel, non-plastic, very stiff, damp.	SS	10	BG			21
		Gray, fine to medium SAND, trace gravel, non-plastic, hard, dry.	SS	12	BG			44
35		Gray and pale yellow, fine to medium SAND, 15% silt, trace fine gravel, non-plastic, hard, damp.	SS	12	BG	698.4		47
		Gray, fine to medium SAND, 20% fine gravel, non-plastic, very hard, damp.	SS	8	BG			54
		Gray, fine to medium SAND, 20% silt, trace gravel, non-plastic, very stiff, moist.	SS	8	BG			27
40		Gray to dark gray, fine to coarse SAND, 10% silt, trace gravel, non-plastic, stiff, wet to saturated.	SS	8	BG	693.4		15
		Boring terminated at 42 ft.						
45						688.4		

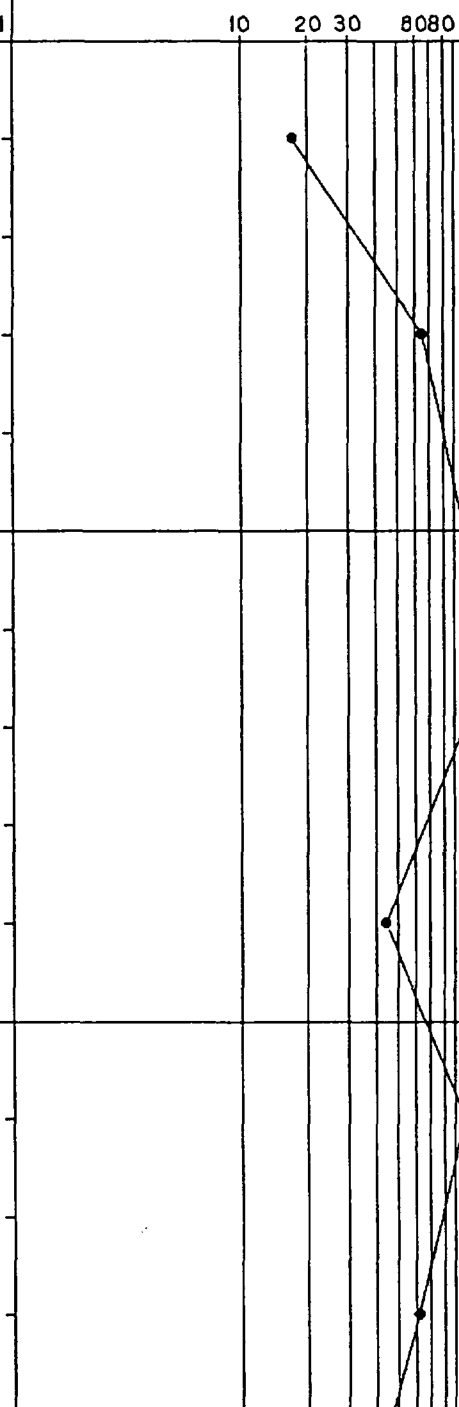
RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-65

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 732.3 (ft.)	N VALUE
	Light olive brown (2.5y 5/3) SILT, 20% clay, 5% angular gravel, very stiff, dry.	SS	8	1.2		17
	Pale yellow (2.5y 7/3) SILT, 30% subangular gravel, 10% sand, very hard, dry. Bag sample.	SS	10	1.8		85
5	Same.	SS	4	2.2	727.3	100
		SS	3	1.2		100
	Light yellowish brown (2.5y 6/4) SILT, 10% clay, 5% sand, 5% fine rounded gravel, hard, dry. (TILL)	SS	NR	1.0		44
10	Same, very hard.	SS	3	1.0	722.3	100
	Same, non-plastic, moist.	SS	10	1.0		82

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-25-94	DATE FINISHED: 10-25-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger	
GEOLOGIST: S. Poole	DRILLER: D. Roelker
WATER LEVEL: --	

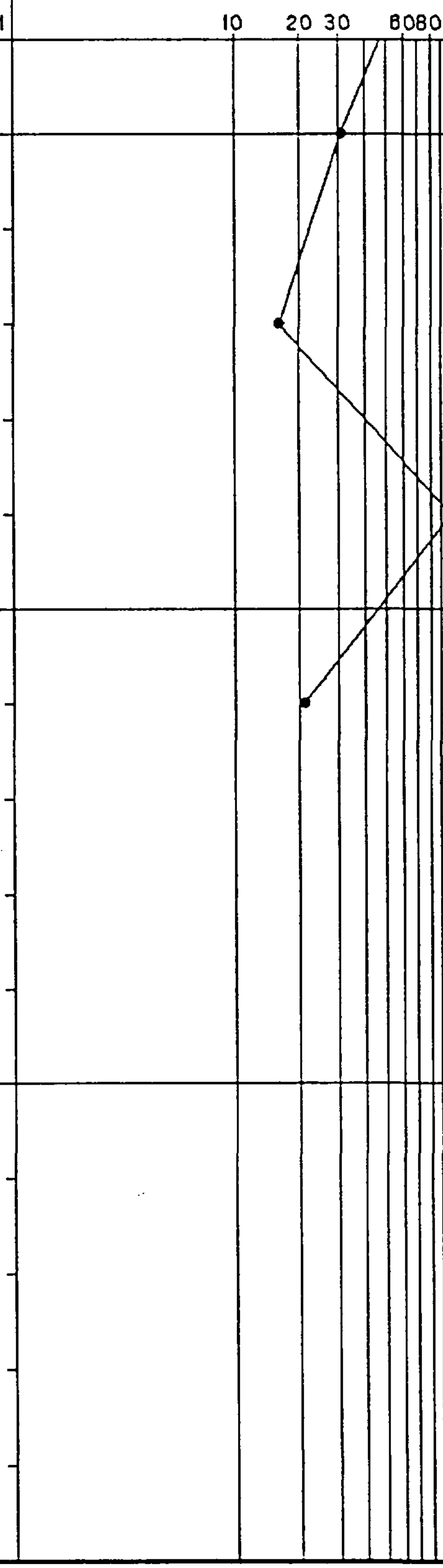
NOTES:
SS = Split Spoon Sample
NR = No Recovery
FID background is 1ppm.

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-65

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 732.3 (ft.)	N VALUE
15	Light olive brown (2.5y 5/4) SILT, 20% sand, 5% rounded gravael, 5% clay, hard, damp. (TILL)	SS	10	3.8	717.3	31
	Light olive brown (2.5y 5/4), silty SAND, poorly graded, fine grained, interbedded with thin strings of medium to coarse 2% rounded gravel, stiff, moist.	SS	15	82		18
	3" same 16" SAND, Moist to wet.	SS	19	85		100
20	Same, gray (5y 5/1), saturated.	SS	12	48	712.3	21
	Boring terminated at 22 ft.					
25					707.3	

STANDARD PENETRATION TEST DATA (blows/ft)



RUST Environment & Infrastructure

Client: Skinner PRP Group Project: Skinner ROI Location: West Chester, Ohio Project No: 72680.300	LOG OF BORING NO. B-66

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	FID (ppm)	ELEV. (MSL) 732.2 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Pale yellow (2.5y 7/4) SILT, 30% small to large gravel, 10% sand, non-plastic, hard, dry.	SS	17	1.0			32
		Pale yellow (2.5y 7/4) SILT, 20% fine to medium subangular gravel, laminar structure, thin, very hard, dry.	SS	8	0.7			100
5		Same, very stiff, dry. Bag sample taken from 4-7 ft.	SS	13	2.0	727.2		29
		5" same, no partings, stiff, dry. 9" SILT, 10% clay, 10% fine subangular gravel, low plasticity, stiff, moist.	SS	14	0.8			23
		Light olive brown (2.5y 5/4) same, with subrounded gravel, very stiff, moist.	SS	19	1.8			29
10		Light olive brown (2.5y 5/4) SILT, 20% clay, 20% subangular gravel, 2% sand, low plasticity, very stiff, moist.	SS	15	1.2	722.2		25
		3" Same. 3" Limestone gravel. 9" SAND, 10% silt, 10% gravel, rounded, moist.	SS	13	4.0			35
15		Light olive brown (2.5y 5/4) same with 10% to 30% silt, very stiff, damp.	SS	12	2.0	717.2		29
		Light olive brown (2.5y 5/4) SAND, 5% silt, 5% fine subrounded gravel, very stiff, damp. Bag sample taken from 16 to 18 ft,	SS	12	0.8			28

DATE STARTED: 10-25-94	DATE FINISHED: 10-25-94	NOTES: SS = Split Spoon Sample ND = No Data Available FID background is 1.0 ppm.
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger		
GEOLOGIST: S. Poole	DRILLER: D. Roelker	
WATER LEVEL: --		

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio — Project No: 72680.300

LOG OF BORING NO. B-66

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 732.2 (ft.)	N VALUE
	Same, no silt, damp.	SS	12	0.8		
		SS	8	1.0		100
20	Same, damp.				712.2	
		SS	7	2.8		100
	Light olive brown (2.5y 5/4) CLAY, 10% fine to coarse rounded gravel, 5% silt, 2% sand, very hard, moist. Sand seam at 22.5 ft. with black staining. (TILL)	SS	12	3.0		100
25		SS	3	0.8	707.2	100
	3" Light olive brown (2.5y 5/4) CLAY, 10% silt, 10% gravel, dry.					
	7" Light olive brown (2.5y 5/4), poorly graded SAND (SP), 20% silt very hard, wet, very thin stringer of coarse sand at 27.5 ft.	SS	10	1.8		100
	Poorly graded SAND, medium to coarse, 2% rounded gravel, hard, wet to saturated.	SS	22	0.45		31
30	Boring terminated at 30 ft.				702.2	
35					697.2	

STANDARD PENETRATION TEST DATA (blows/ft): 10 20 30 8080

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-67

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 884.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Dark brown silty sandy CLAY with some gravel, very stiff. (FILL)	SS	1.5	BG			28
		Brown silty clayey SAND with limestone fragments and gravel, stiff. (FILL)	SS	6	BG			12
5		Yellow mottled silty sandy CLAY, stiff.	SS	15	BG	879.8		13
		4" Yellow sandy CLAY. 4" Fossiliferous limestone. Very hard.	SS	8	BG			100
		4" Brown yellow clayey SAND. 8" Yellow clayey silty SAND with dark brown stain and limestone. 2" Gray CLAY.	SS	14	BG			47
10		Dark brown yellow silty sandy CLAY with limestone, very hard.	SS	6	BG	874.8		100
		Dark brown clayey sandy SILT with limestone fragments.	SS	4	BG			37

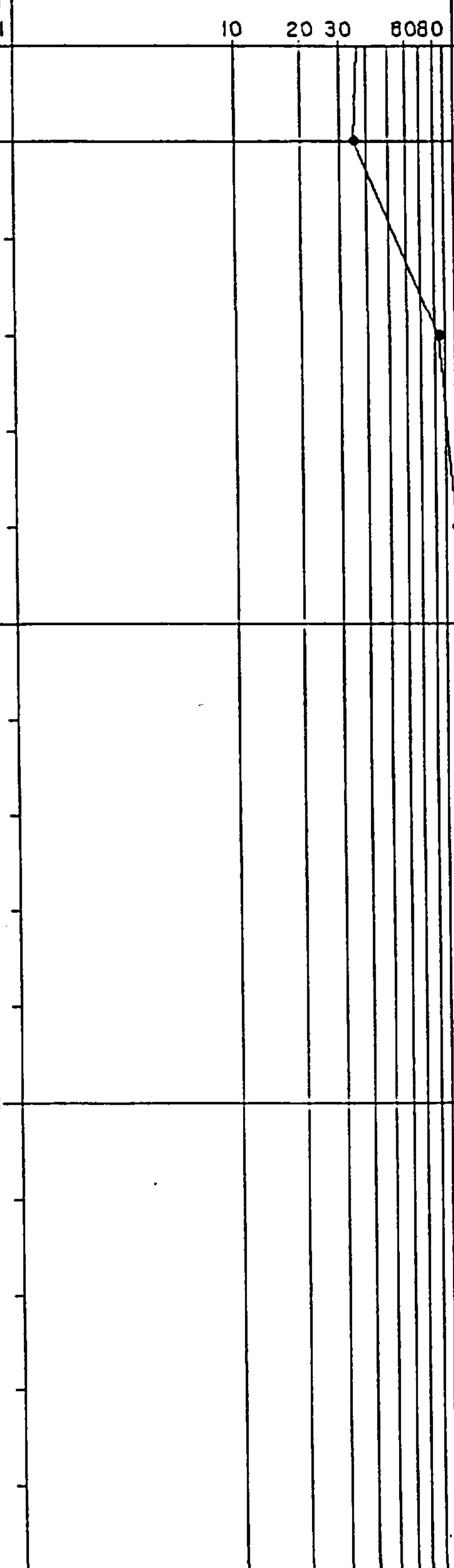
DATE STARTED: 10-19-94	DATE FINISHED: 10-19-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ NQ Core	
GEOLOGIST: P.D. Thompson	DRILLER: D. Roelker
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
BG = Background
PID background is 1.0 ppm

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-67

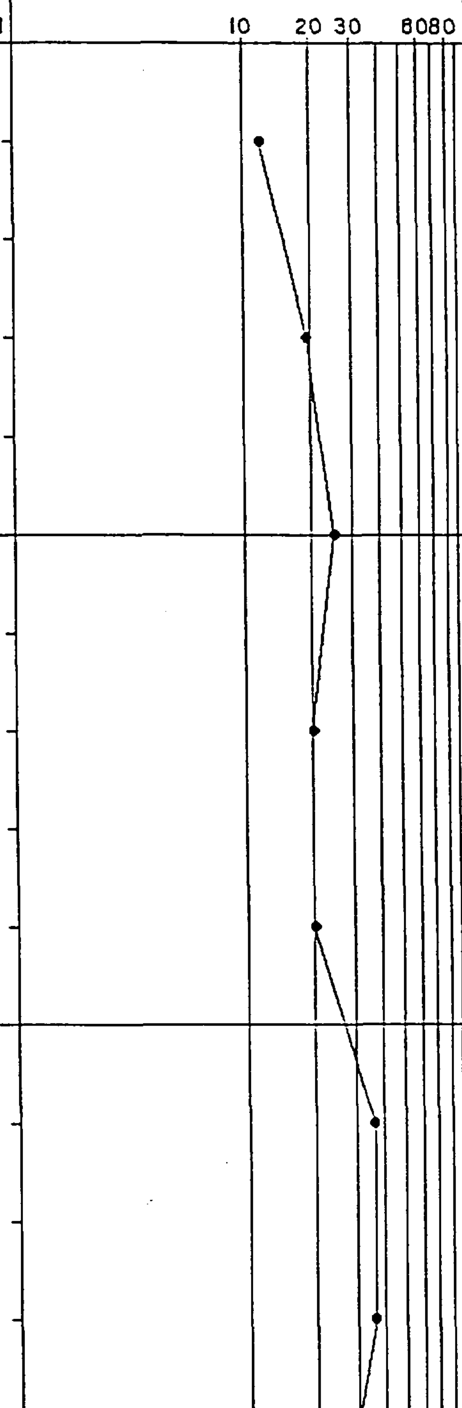
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 884.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
15		3" Dark brown yellowish CLAY, saturated. 3" Gray silty sandy CLAY. (TILL)	SS	8	BG	869.8		35
		Gray silty sandy CLAY. (TILL)	SS	15	BG			84
		No recovery.	SS	0	BG			100
20		Core 2 ft. Fossiliferous limestone.	CORE	5	BG	864.8		
		Boring terminated at 22 ft.						
25						859.8		



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-69

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 686.4 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
		Brown clay, 30% silt, plastic, stiff, moist.	SS	6	BG			12
		Top 5" same. Bottom 5" Gray CLAY, 20% silt, trace fine gravel, plastic, very stiff, moist. (TILL)	SS	10	BG			18
5		Gray SILT, trace fine gravel, non-plastic, very stiff, moist. (TILL) 1" Silt and fine sand layer.	SS	11	BG	681.4		25
		Gray SILT, 20% clay, slightly plastic, stiff, damp. (TILL)	SS	10	BG			20
		Same. Bag sample taken.	SS	10	BG			20
10		Gray SILT, 10% clay, non-plastic, hard, damp. (TILL)	SS	8	BG	676.4		38
		Same.	SS	10	BG			38



DATE STARTED: 11-18-94
DATE FINISHED: 11-18-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core
GEOLOGIST: K. Heaton
DRILLER: J. Murphy
WATER LEVEL: 20 ft. on 11-18-94

NOTES:
SS = Split Spoon Sample
ND = No Data Available
BG = Background
PID background is 0.8 ppm.
∇ = Initial Water Level

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-69

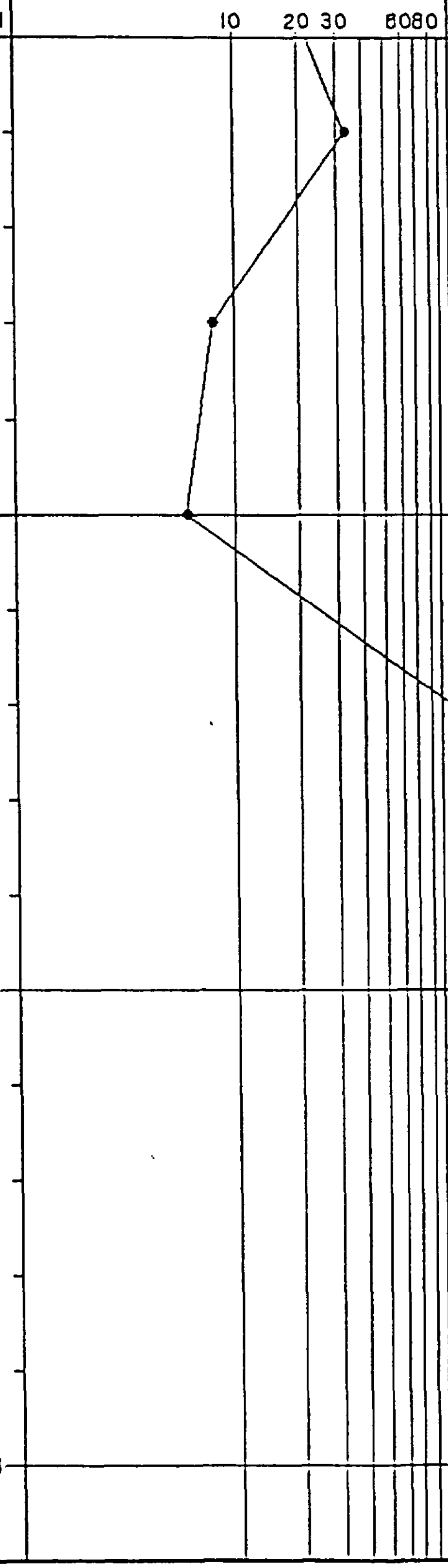
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 888.4 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
15		Same, trace medium sand. Methane detected in augers.	SS	10	BG	871.4		25
		Coarse SAND and fine gravel. 40% fines, dense, damp.	SS	8	BG			45
		Gray CLAY, trace fine gravel, plastic, stiff, moist. (TILL)	SS	18	BG			12
20		Gray coarse SAND and fine gravel, 20% fine sand, medium dense, saturated.	SS	11	BG	866.4		22
		Gray medium SAND, 20% coarse sand and fine gravel, 25% fine sand, dense, saturated.	SS	7	BG			34
25		Gray CLAY, trace coarse gravel, trace coarse sand, hard, damp. (TILL)	SS	5	BG	861.4		38
		Gray soft CLAY, silt, fine to coarse sand, fine gravel, saturated. (TILL)	SS	7	BG			15
		Gray SILT, 10% coarse sand, non-plastic, medium dense, saturated.	SS	10	BG			11

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-69

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 886.4 (ft.)	N VALUE
		Gray SILT and coarse sand, very stiff, saturated.	SS	10	BG		33
		Gray SILT, trace organics, non-plastic, stiff, saturated.	SS	13	BG		8
35		Same.	SS	12	BG	851.4	8
		Same. Lower 2" is fine to medium angular gravel.	SS	11	BG		100
		Gray fossiliferous LIMESTONE interbedded with gray calarious weathered shale. No sign of fracturious, low permability, low porosity.	Core	10	BG		100
40		Boring terminated at 40 ft.				846.4	
45						841.4	

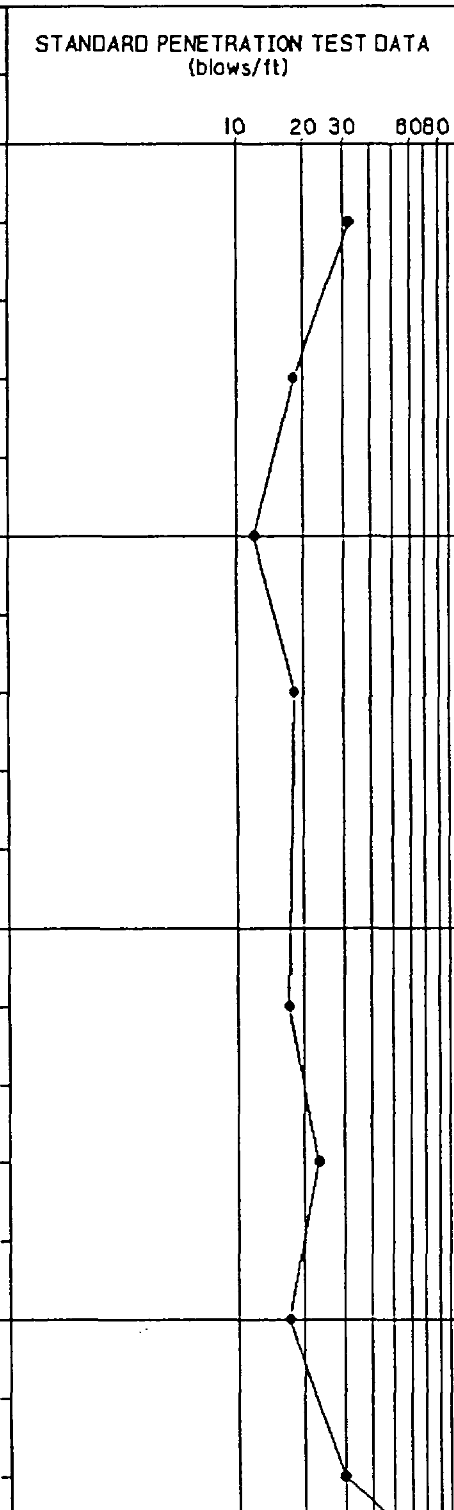
STANDARD PENETRATION TEST DATA (blows/ft)



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-70

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 707.8 (ft.)	N VALUE
		Tan, medium SAND, 30% silt, 15% coarse SAND, dense, damp.	SS	12	BG		32
		Brown CLAY, 20% silt, plastic, very stiff, moist.	SS	8	BG		18
5		Brown CLAY, fine to coarse gravel, plastic, stiff, moist.	SS	2	BG	702.8	12
		Brown CLAY, 20% silt, 10% fine gravel, plastic, moist, At 7' becomes olive brown SILT, 20% clay, 20% fine gravel, very stiff, saturated.	SS	18	BG		18
		No sample.	NS	NS	NS		
10		Olive brown SILT, 20% clay, 20% fine gravel, very stiff, saturated.	SS	6	BG	697.8	17
		Brown coarse SAND, 15% fine sand, 5% fine gravel, medium dense, saturated.	SS	10	BG		23
15		Gray SILT, 35% limestone chips, very stiff, damp.	SS	4	BG	692.8	17
		Gray fine SAND, trace fine gravel, wet. Lower 2" is gray till.	SS	4	BG		30



DATE STARTED: 11-16-94	DATE FINISHED: 11-17-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: K. Heaton	DRILLER: J. Murphy
WATER LEVEL: 7 ft. on 11-16-94	

NOTES:
SS = Split Spoon Sample
NS = No Sample
BG = Background
PID background is 0.8 ppm.
/A = Initial Water Level

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-70

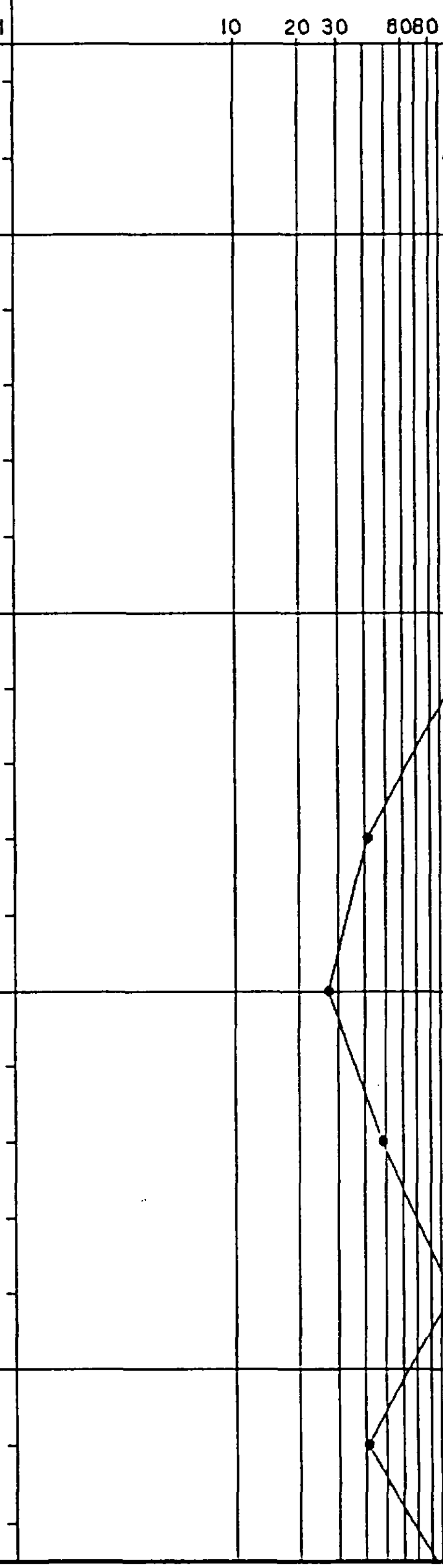
DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 707.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		SS	4	BG			
	Gray SILT and fine sand, trace fine gravel, crumbly hard, damp.	SS	8	BG			100
20	Gray medium SAND, 40% silt, moist. Lower 2" is till, damp.	SS	5	BG	687.8		100
	Gray TILL, hard, damp.	SS	ND	BG			48
25	Gray TILL, damp. Lower 1" is silt, hard, mosit.	SS	18	BG	682.8		100
	Gray TILL, hard, damp. 6" Coarse SAND, dense, wet.	SS	12	BG			38?
	Gray coarse SAND, dense, saturated.	SS	14	BG			
30	Same. Lower 8" is TILL, hard, damp.	SS	14	BG	677.8		31
	TILL with trace pieces of shale, damp.	SS	12	BG			52
35	TILL, same, damp.	SS	11	BG	672.8		100
	TILL, same, damp.	SS	12	BG			100

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

LOG OF BORING NO. B-70

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 707.8 (ft.)	N VALUE
	Gray TILL.	SS	12	BG		
		SS	0	BG		100
40	Gray SILT and medium SAND, 20% coarse sand, 5% fine gravel, non-plastic, hard, damp.	SS	8	BG	667.8	100
	TILL, damp.	SS	10	BG		100
		NS	NS	NS		
45	Limestone pieces in tip. at shoe.	SS	1	BG	662.8	100
	Black fine SAND, 30% silt, dense, saturated. No petroleum odor.	SS	8	BG		41
50	Gray with a trace of black, fine SAND and SILT, saturated. Gray SILT, non-plastic, hard, saturated.	SS	24	BG	657.8	27
	Gray SILT, trace black thin laminae, non-plastic, hard, saturated.	SS	24	BG		48
	Angular gray LIMESTONE fragments, sand, and gravel, very dense, wet.	SS	8	BG		100
55	Gray fossilferous LIMESTONE fragments, silt, sand, and gravel, very dense, wet.	SS	8	BG	652.8	41
	Same.	SS	4	BG		

STANDARD PENETRATION TEST DATA (blows/ft)



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-70

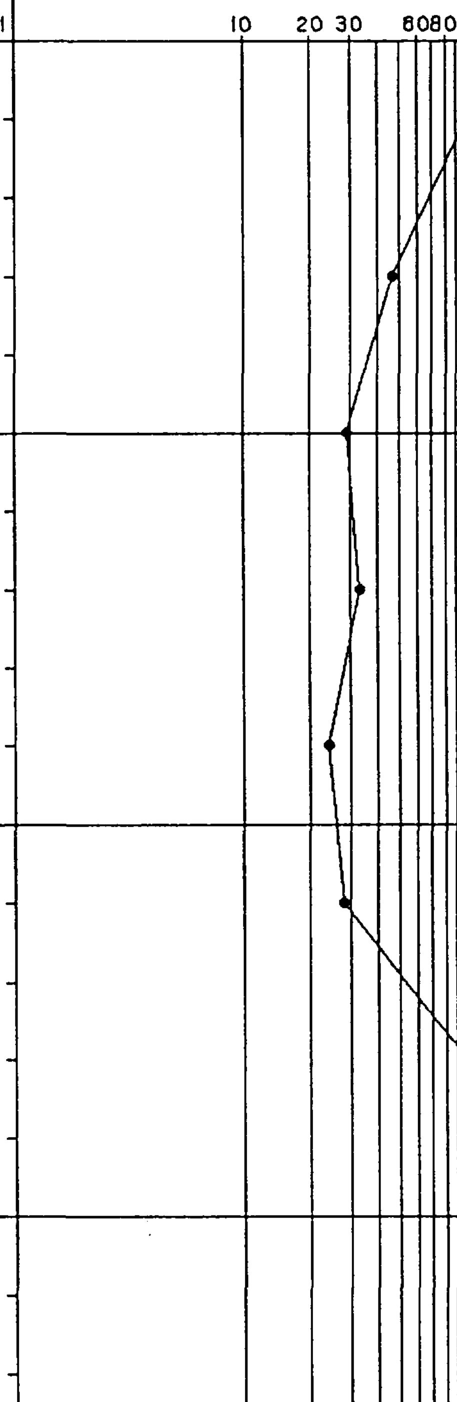
DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 707.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
			SS	4	BG			100
60		Gray fossilferous LIMESTONE with interbedded gray calcarious shale. No evididence of weathering or fracturing. Low permeability and low porosity.	Cqre	33.5	BG	647.8		ND
		Boring terminated at 62 ft.						
65						642.8		
70						637.8		
75						632.8		

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-73

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 889.5 (ft.)	N VALUE
	Slag with iron cinders, orange staining, brown silty lean clay with gravel. (FILL)	SS	8	BG		100
	Dark yellowish brown (10yr 3/6) SAND, 20% CLAY, and gravel and limestone fragments.	SS	12	BG		48
5	Dark brown SAND, 15% small gravel, 10% clay, and some limestone fragments.	SS	12	BG	884.5	29
	Gray (10yr 5/1) SAND, 25% clay with fine gravel. (TILL)	SS	8	BG		33
	Dark gray CLAY, 20% sand. (TILL)	SS	9	BG		24
10	Dark gray (5y 4/1) sandy lean CLAY with limestone fragments and some gravel. (TILL)	SS	4	BG	879.5	28
	Dark gray sandy lean CLAY with traces of gravel. HQ rock coring begins at 12.1 ft. Limestone and weathered shale.	CORE	18	BG		100
15	Boring terminated at 14.1 ft.				874.5	

STANDARD PENETRATION TEST DATA (blows/ft)



DATE STARTED: 10-18-94	DATE FINISHED: 10-18-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ NQ Core	
GEOLOGIST: P D. Thompson	DRILLER: D. Roelker
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
ND = No Data Available
BG = Background
FID background is 0.2 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-74

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 893.5 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		5" Dark brown clayey SAND. 6" Dark brown SAND with limestone, orange staining. 4" Dark brown SAND with gravel, orange staining. (FILL)	SS	15	BG			34
		Dark brown clayey sandy SILT with fragments of limestone and some gravel. (TILL)	SS	5	BG			100
5		Medium gray weathered SHALE with limestone fragments and some gravel.	SS	12	BG	888.5		28
		HQ rock coring begins at 6 ft. 3.5" Fossilferous weathered LIMESTONE. 5" Weathered shale. 2" Broken pieces of weathered shale.	CORE	10.5	BG			
		Boring terminated at 8 ft.						
10						883.5		

DATE STARTED: 10-18-94
DATE FINISHED: 10-18-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ NQ Core
GEOLOGIST: P D. Thompson
DRILLER: J. Murphy
WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
BG = Background
FID background is 1.0 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-75

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (Inches)	PID (ppm)	ELEV. (MSL) 899.1 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Grayish brown (10yr 5/2) CLAY, 30% silt, 5% fine gravel, coal fragments, bottom 2" pulverized limestone, very stiff, dry.	SS	10	0.1			30
		Dark grayish brown (10yr 4/2) CLAY, 40% silt, fine laminae of darker brown, hard, dry. 6" Limestone with thin interbeds of weathered shale. (2.5y 7/4). dry.	SS	10	0.4			34
5		Limestone, chipped, dry.	SS	2	1.2	894.1		33
		1.5" Pale olive (5y 6/3) CLAY (weathered shale) with two thin laminae of gray, very stiff, dry. 5% chips of shale. 1.5" Limestone.	SS	4	0.0			23
		Gray fossilferous LIMESTONE Thin (<0.1) fractures every 2-4 inches.	Core	8	0.1			
10		Boring terminated at 9.9 ft.				889.1		

DATE STARTED: 10-7-94   DATE FINISHED: 10-7-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core
GEOLOGIST: S. Poole   DRILLER: J. Murphy
WATER LEVEL: --

NOTES:
SS = Split Spoon Sample
PID background is 0.1 ppm.

RUST Environment & Infrastructure

LOG OF BORING NO. B-76

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio
Project No: 72680.300

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 884.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Top 1" Dark brown sandy CLAY with brick, gravel and concrete. Very hard, damp.	SS	2	BG			100
		Very dark grayish brown (10yr 3/20) sandy CLAY with gravel. (FILL)	SS	18	BG			18
5		Dark to light brown sandy CLAY with gravel and white granular material. (FILL)	SS	8	BG	879.8		13
		Same.	SS	8	BG			28
		Same, dark gray with white granular material. (FILL)	SS	7	BG			26
10		Gray SAND, 20% clay with gravel. Gray (7.5yr) silty clayey sand with gravel. Bag sample taken from 10-12 ft.	SS	24	BG	874.8		48
			SS	20	BG			71

DATE STARTED: 10-14-94	DATE FINISHED: 10-14-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ NQ Core	
GEOLOGIST: P.D. Thompson	DRILLER: D. Roelker
WATER LEVEL: --	

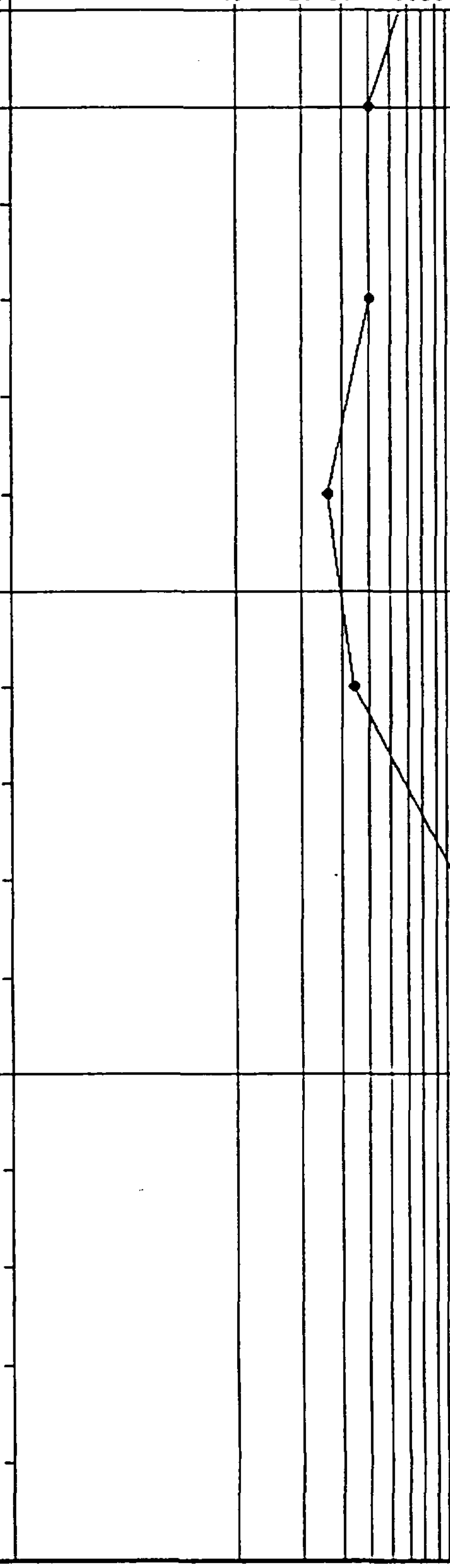
NOTES:
SS = Split Spoon Sample
ND = No Data Available
BG = Background
FID background is 0.5 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72680.300

LOG OF BORING NO. B-76

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 884.8 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
15		Gray (7.5yr) silty sandy CLAY with gravel, very wet. (TILL)	SS	18	BG	889.8		40
		Dark gray (5y 4/1) silty sandy CLAY with gravel. (TILL)	SS	24	BG			40
		Dark gray (5y 4/1) sandy silty CLAY with gravel, damp to wet. (TILL)	SS	24	BG			28
20		CLAY till to 21 ft. Sandy SILT with trace gravel.	SS	24	BG	884.8		34
		Dark gray (2.5yr 4/1) sandy CLAY with trace gravel at 23 -24 ft., dark gray till sandy silty CLAY at 22.5 to 23 ft. Saturated. (TILL)	SS	20	20			100
25		NQ coring begins at 24 ft. 1" Till and 4" of fossiliferous LIMESTONE. Bottom of limestone bedding plane is smooth with a slight dip.	CORE	5	ND	859.8		
		Boring terminated at 26 ft.						



Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-78

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	FID (ppm)	ELEV. (MSL) 688.0 (ft.)	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 6080	N VALUE
		Dark brown CLAY, 30% silt, 5% rounded gravel, 5% sand, 5% white powder, dry. (FILL)	SS	7	BG			18
		4" Same, dry. 4" 60% pulverized limestone, 30% white powder. (FILL)	SS	8	BG			33
5		2" Well graded SAND, 20% gravel, dry. 2" Olive CLAY, 1% sand, very hard, dry.	SS	4	BG	683		100
		Yellow brown SILT, 10% clay, 10% fine sand, dry. Bag sample taken from 6-10 ft.	SS	6	BG			100
		3" Same with thin laminae of gray and brown. 6" Well graded SAND, 20% fine to medium angular gravel, damp.	SS	8	BG			100
10		1.5" Medium GRAVEL, rounded, high sphericity 6.5" Pulverized fossilferous LIMESTONE. 1.5" Limestone, bottom bedding plane is smooth and flat. 3" Very thin weathered shale, then limestone. 1.5" Limestone. 0.5" Weathered shale, gray. All bedding planes are flat and smooth.	CORE	15	ND	678		100
		Boring terminated at 11.3 ft.						

DATE STARTED: 10-17-94	DATE FINISHED: 10-17-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

NOTES:
SS = Split Spoon Sample
ND = No Data Available
BG = FID background is 1.0 ppm.

RUST Environment & Infrastructure

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio Project No: 72680.300

LOG OF BORING NO. B-79

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 885.0 (ft.)	N VALUE
		Dark grayish brown (10yr 4/2) grades to white (10yr 8/1) well graded SAND, 40% angular gravel, 10% silt, dry. (FILL)	SS	10	0.8		100
		Crushed rock, dry. (FILL)	SS	1	1.0		100
5		Brown (10yr 5/3) grades to gray (5y 5/1) poorly graded SAND, 50% gravel grades to 30% gravel, 10% silt, damp to moist, smell of contaminants.	SS	5	1.2	880	42
		Gray (5y 5/1) poorly graded SAND, 5% silt, wet.	SS	4	0.8		44
		Gray (5y 5/1) poorly graded SAND, 10% gravel, 5% silt, wet to 9.3 ft.	SS	10	ND		41
10		Gray CLAY, 10% rounded gravel, 2% sand, damp. (TILL)				875	
		Same with 15% rounded gravel, strong odor during drilling, moist.	SS	8	0.8		45
		3" Dark gray well graded SAND, 10% silt, 5% gravel, saturated. 3" Dark gray CLAY, 20% gravel, 10% sand, wet. (TILL)	SS	8	0.8		34

STANDARD PENETRATION TEST DATA (blows/ft)

10 20 30 6080

DATE STARTED: 10-18-94	DATE FINISHED: 10-18-94
DRILLING METHOD: 4-1/4" ID Hollow Stem Auger/ HQ Core	
GEOLOGIST: S. Poole	DRILLER: J. Murphy
WATER LEVEL: --	

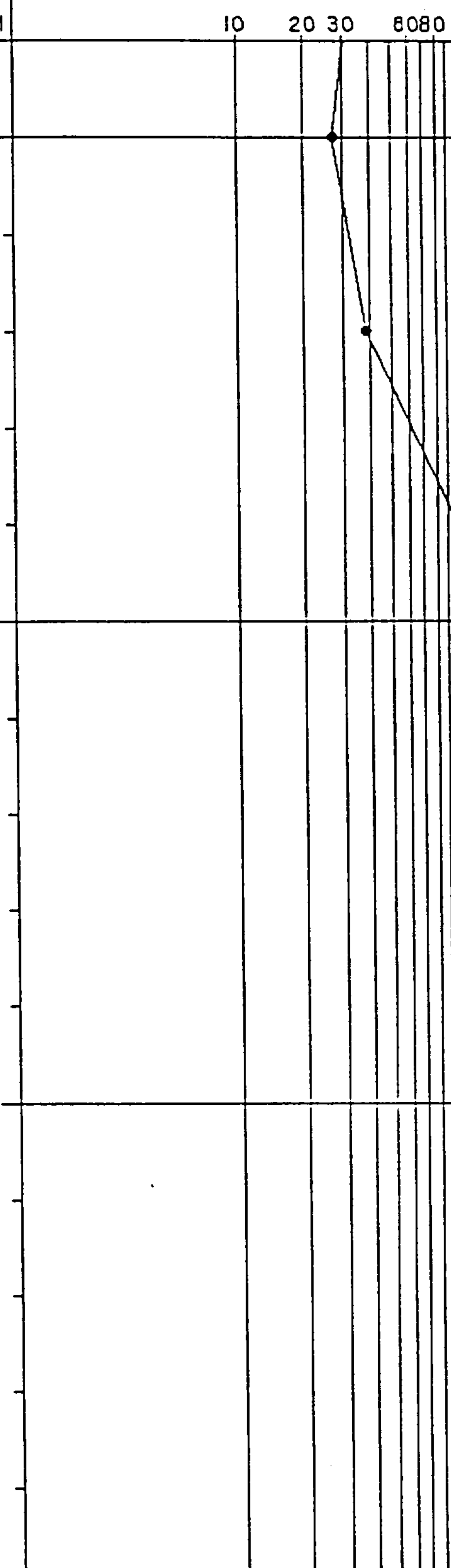
NOTES:
SS = Split Spoon Sample
ND = No Data Available
PID background is 0.8 ppm.

Client: Skinner PRP Group
Project: Skinner RDI
Location: West Chester, Ohio   Project No: 72880.300

LOG OF BORING NO. B-79

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	RECOVERY (inches)	PID (ppm)	ELEV. (MSL) 885.0 (ft.)	N VALUE
15		Same, moist.	SS	5	0.8	870	27
		Dark gray CLAY, 10% rounded gravel, 5% sand, moist. (TILL)	SS	12	0.8		38
		Same.	SS	7	0.8		100
20		Auger refusal at 18.7 ft. HQ rock coring begins. Limestone gravel.	Core	8	ND	865	
		Boring terminated at 20.7 ft.					
25						860	

STANDARD PENETRATION TEST DATA (blows/ft)



APPENDIX V

RUST ENVIRONMENT & INFRASTRUCTURE

MEMORANDUM

Cincinnati Division

FILE

Date: November 8, 1994

To: Bruce Sypniewski, USEPA, Chicago, Illinois

From: Jim Veith, RUST E&I Inc., Cincinnati, Ohio

cc: Larry Bone, Skinner Landfill PRP Group
Ed Need, RUST E&I Inc., Chicago, Illinois
Greg Youngstrom, OEPA, Dayton, Ohio

Project: Skinner Landfill Remedial Design Investigation

Subject: Alternate Trench Alignment Borings

The project Work Plan proposed borings on the knob south of the buried lagoon for investigating an alternate alignment for the downgradient groundwater control trench. Our anticipation was that we would find a bedrock high or ridge across the knob favorable to locating the collection trench northward from the alignment following the creek. However, this has not been the case. We are, therefore, proposing to modify the exploration program on the knob.

Attached Figure 1 is a plan view of the site area south of the buried lagoon. This plan is based on the 1994 topographic mapping and varies slightly from the site plans submitted with the Work Plan. Shown on this figure are the trench alignment along the creek and the alternate alignment across the knob as originally presented in the Work Plan documents. Also shown on Figure 1 are RI borings/wells, the Remedial Design Investigation (RDI) borings and wells that are completed, and the RDI borings yet to be completed.

Figure 2 is Section A-A' cut through the knob at the location shown on Figure 1. The top of bedrock is shown on Figure 2 based on information from RDI borings completed to date. As can be seen on the cross section, no bedrock high exists on the knob. Overburden in GW-51 consists of a clayey silt cap (probably glacial till) underlain by sand and gravel to the bedrock surface.

On Figure 1 the contours for a conceptual 4:1 cut slope are shown. The cut begins south of the buried lagoon and extends to the valley floor. The conceptual cut slope is also shown on Figure 2. Please note that this is a possible configuration for the cut, and is based on materials encountered and current topography. Determination of whether or not the cut will be made depends on the need for fill for the landfill cap construction. If no cut is made

11785 Highway Drive, Suite 100, Cincinnati, Ohio, 45241, Phone: 513-733-9374, Fax: 513-733-8213

the groundwater collection trench will not be pushed northward into the slope because of the depth to bedrock. If a cut is made, a more probable alignment for the trench would be from GW-50 to B-70 to B-79 near the toe of the 4:1 slope, not from B-70 to B-71 to B-72 as indicated on Figure 1.

Based on the information to date we propose the following modification in the field investigation plan. Borings B-68, B-71, B-72 and b-77 will be eliminated from the program. These borings will provide no additional information over and above present information for design of the cut slope or selection of an alternate trench alignment. Boring B-70 will be drilled as shown on Figure 1 and boring B-69 will be moved downslope to the alternate trench alignment midway between borings GW-50 and B-70.

Please review this proposed modification to the field investigation program. I will give you a call in the next fee days to discuss.

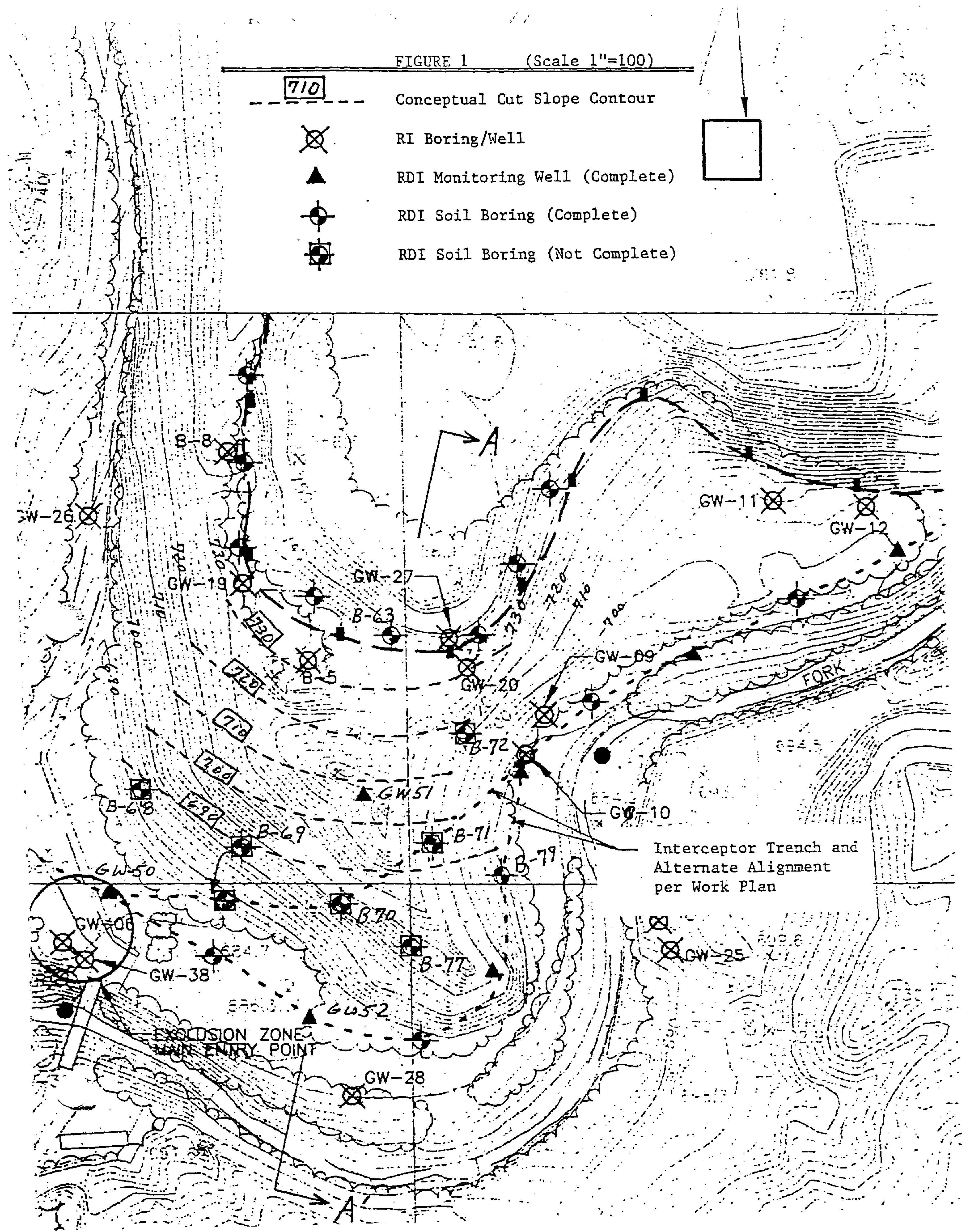
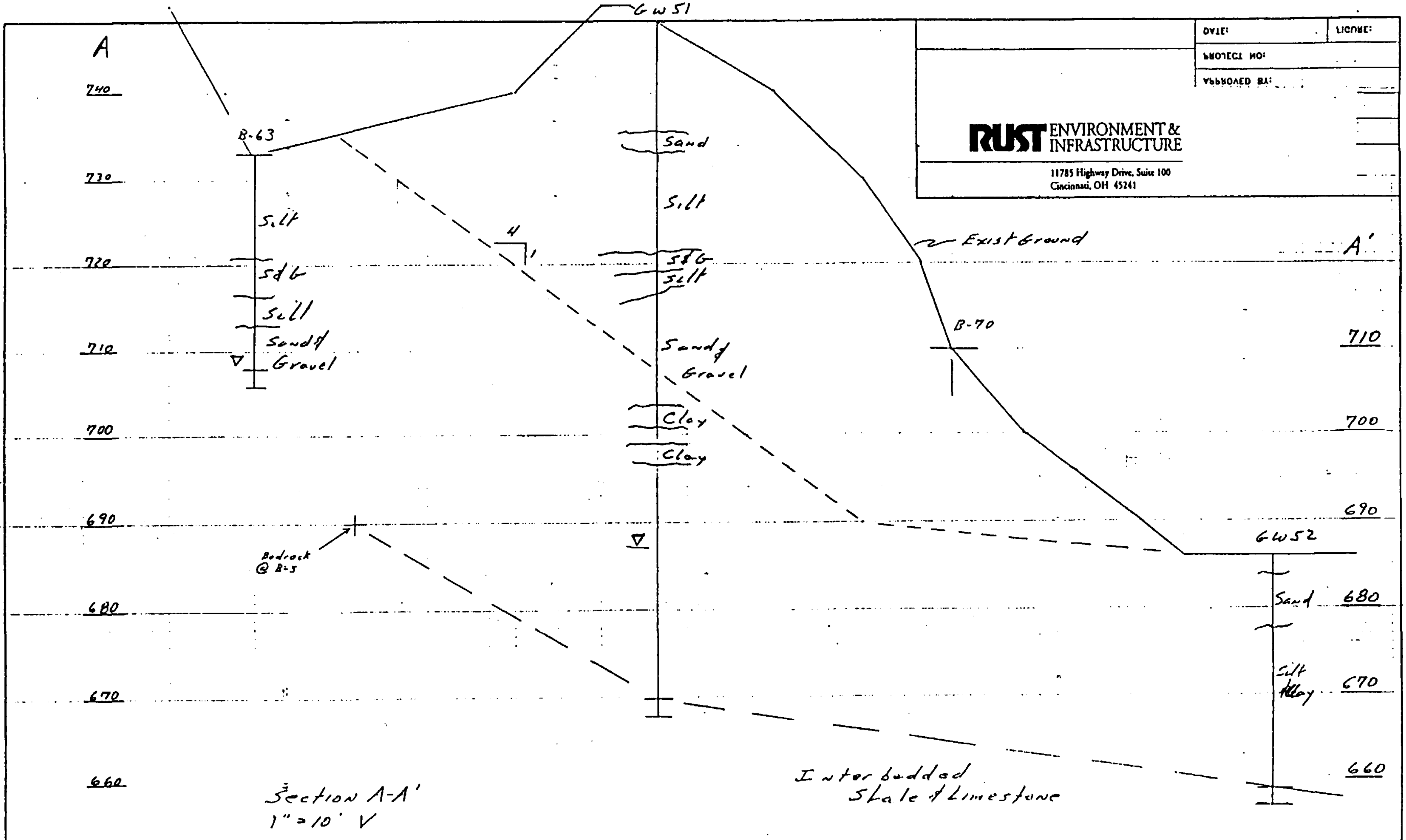


FIGURE 1 (Scale 1"=100)



DATE:
FIGURE:
PROJECT NO:
APPROVED BY:
RUST ENVIRONMENT & INFRASTRUCTURE
11785 Highway Drive, Suite 100
Cincinnati, OH 45241
A
A'
740
730
720
710
700
690
680
670
660
B-63
GW51
B-70
GW52
Silt
Sd G
Silt
Sandy Gravel
Sand
Silt
S&G
Silt
Sandy Gravel
Clay
Clay
Sand
Silt Clay
4
1
Exist Ground
Bedrock @ B-5
Interbedded Shale & Limestone
Section A-A'
1" = 10' V
1" = 30' H

Figure 2

APPENDIX VI

Bail-down recovery tests were performed on the eight wells along the proposed groundwater interception system alignment. A bail-down recovery test estimates the horizontal hydraulic conductivity (K) in the nearby formation around a well.

Upon careful review of the calculated hydraulic conductivity values from initial tests, RUST suspected that the values of K were higher than would be expected considering the geology of the site. The high K values were attributed to drainage from the sand packs around the well screens. Based on the field conditions the bail-down test procedure in the FSP was changed so that the influence of the sand packs could be avoided. The procedures used are described below.

Each well was bailed completely dry, with the exception of Well GW50, which could not be bailed dry. An electronic water level indicator was used to measure recovery of the water in the well over time. Once the recovery values were recorded for each well, the Hvorslev (1951) method was then used to estimate the hydraulic conductivity (K) of the aquifer. This method assumes a medium that is homogeneous, isotropic, infinite and that soil and water are incompressible.

The resulting values for K, presented below are typical for silts and glacial tills, which the well logs show as dominant soil types.

The following variables were used in the analysis:

r is the radius of the well casing (feet)
R is the radius of the sand pack around the well screen (feet)
L is the saturated length of the well screen
T_0 is the time it takes for the water level to rise to 37 percent of the initial change (seconds)
H is the static water level
H-h is the drawdown at any time T
$H-h_0$ is the maximum drawdown, at time T=0
K is the hydraulic conductivity.

R, r, L, and H were determined from well construction logs, casing stickups and static depths to water. $H-h_0$ was determined graphically. A graph of drawdown versus time was made on semi-logarithmic paper (Graph A for each well). A straight line drawn through the data points which intercepts the y-axis at T=0 can estimate a value of maximum drawdown ($H-H_0$). T_0 was also determined graphically. Graph B for each well is a graph of the ratio $H-h_0/H-h$ versus time. T_0 is determined from this graph.

The solution for K is

$$K = \frac{r^2 \ln (L/R)}{2LT_0}$$

The graphs of the data points and the calculations of hydraulic conductivity for each well are presented on the following pages.

Well	Hydraulic Conductivity (U.S. Gallons/Day/Ft^2)
GW50	0.31
GW51	Not Tested
GW52	0.0025
GW53	1.19
GW54	0.08
GW55	0.001
GW56	3.43
GW57	1.19

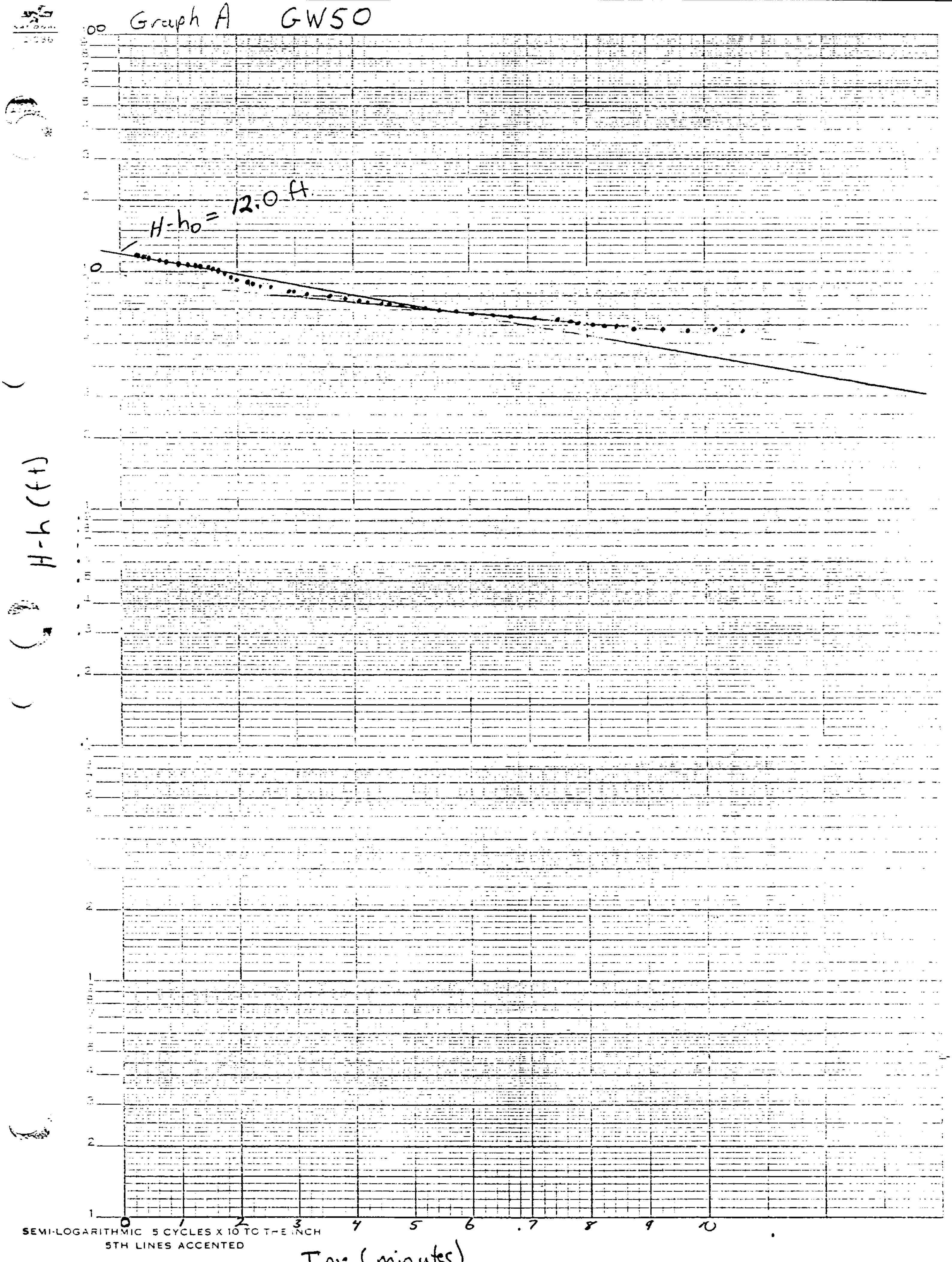
CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW50

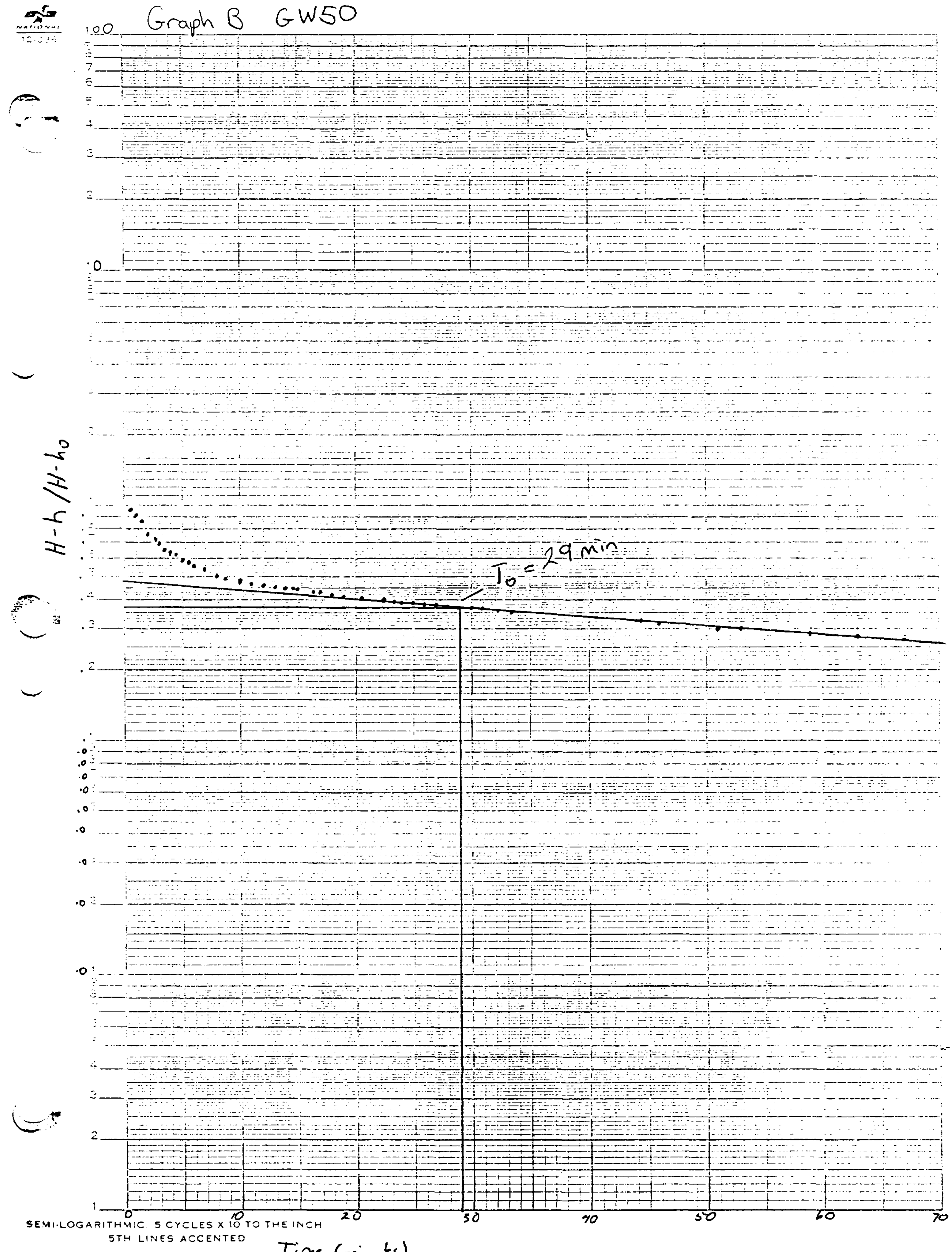
r	=	0.0833 ft
R	=	0.33 ft
L	=	16.32 ft
T_o	=	29 minutes x 60 = 1740 seconds
H	=	15.25 ft
H-ho	=	12.0

$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\,L\,T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{16.32}{0.33}\right)}{2\,(16.32)\,(1740)}$$

$$= 4.77 \times 10^{-7} \text{ ft/s} \times 6.46 \times 10^{5} = 0.31 \text{ gal/day/ft}^2$$


Graph A GW50
H-h₀ = 12.0 ft
H-h (ft)
0 1 2 3 4 5 6 7 8 9 10
Time (minutes)
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED


Graph B GW50
H-h/H-ho
To = 29 min
0
10
20
30
40
50
60
70
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW51

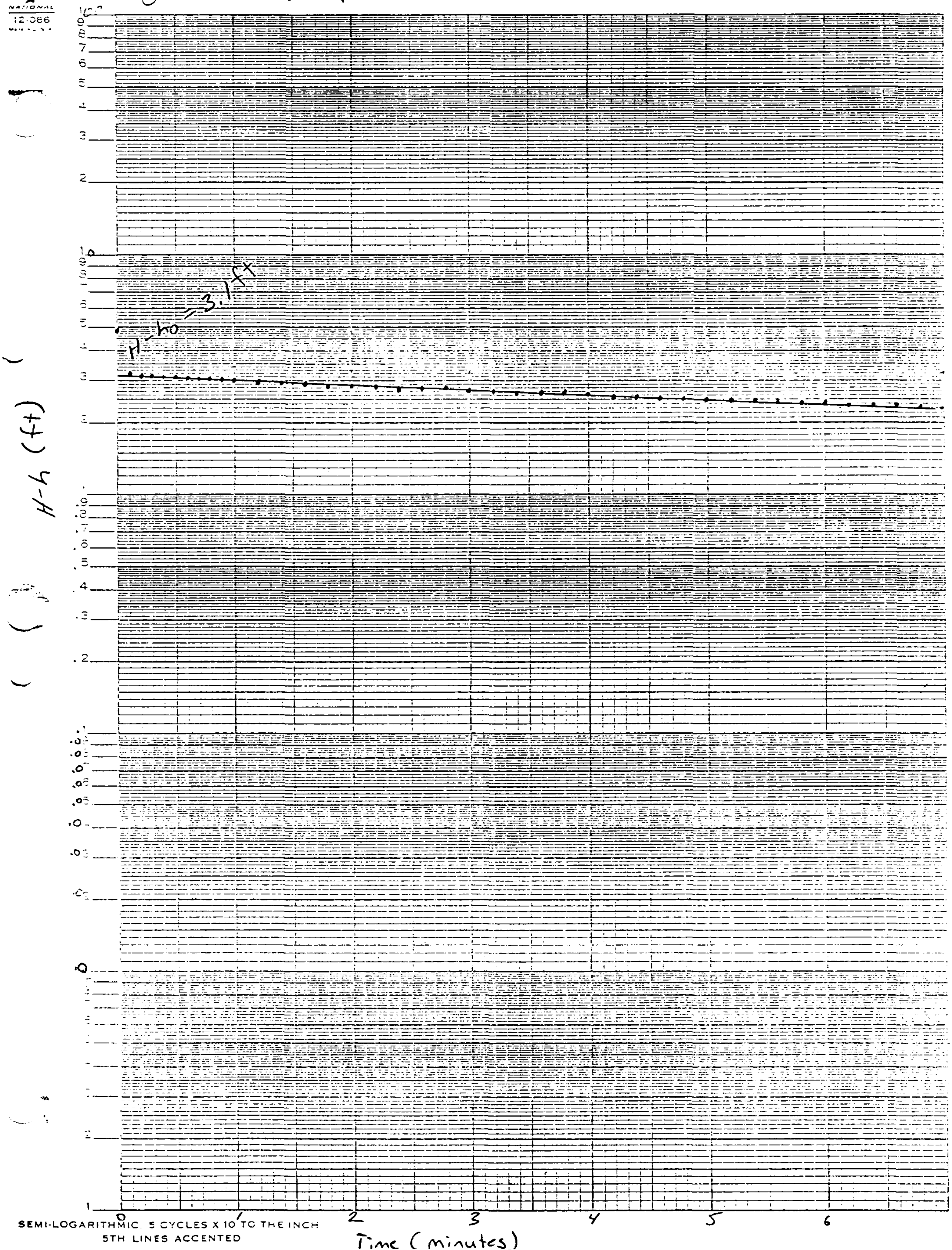
r	=	0.0833 ft
R	=	0.33 ft
L	=	23.58 ft
T_o	=	26 minutes x 60 = 1560 seconds
H	=	38.87 ft
H-ho	=	3.1 ft

$$K = \frac{r^2 \ln\left(\frac{L}{K}\right)}{2 L T_o}$$

$$= \frac{(0.833)^2 \ln\left(\frac{23.58}{0.33}\right)}{2\,(23.58)\,(1560)}$$

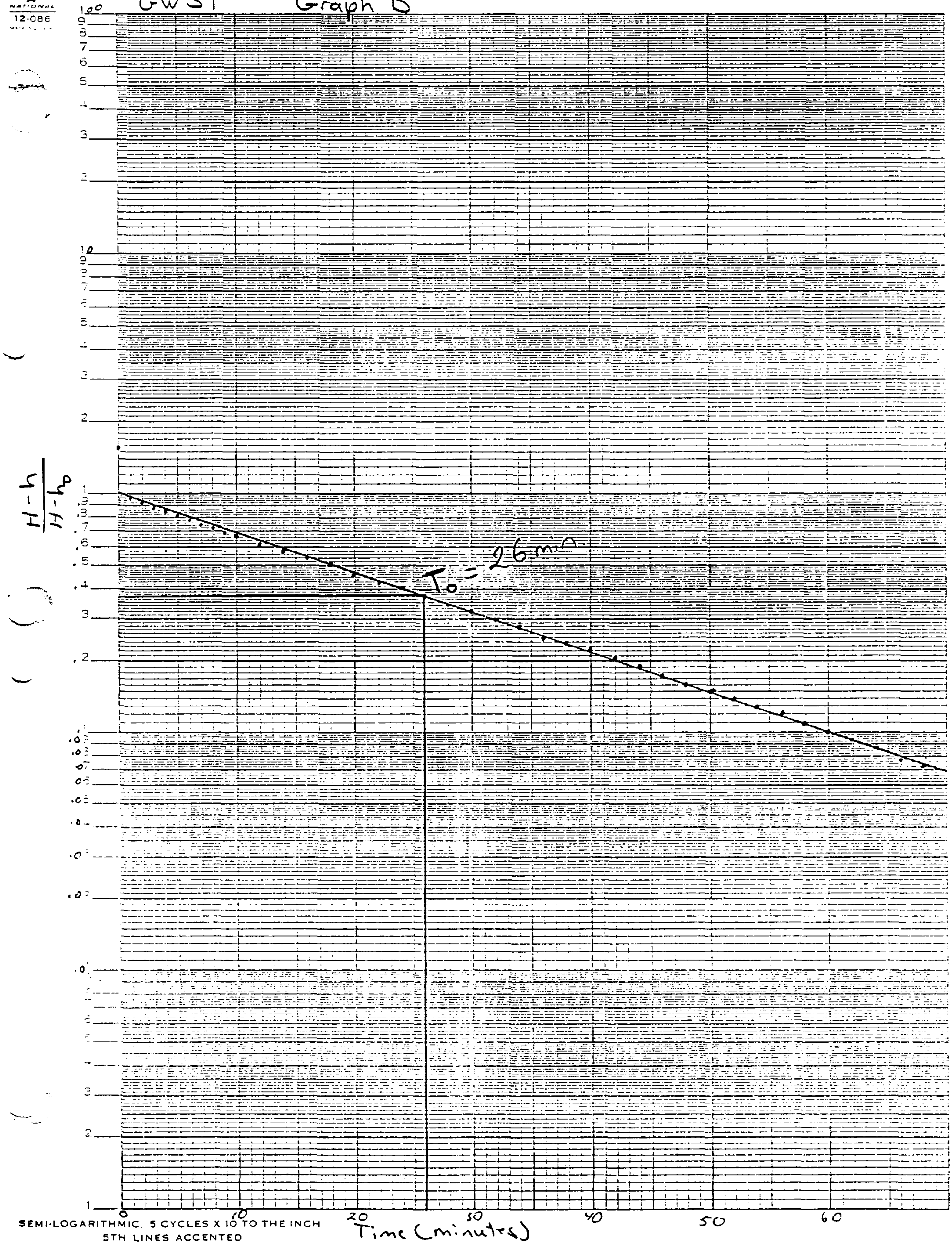
$$= 8.37 \times 10^{-7} \text{ ft/s} \times 6.46 \times 10^5 = 0.54 \text{ U.S. gal/day/ft}^2$$

GWS1 Graph A



$H-h_0 = 3.1 ft$
H-h (ft)
Time (minutes)
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED
NATIONAL 12-086

GW51 Graph B



SEMI-LOGARITHMIC. 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

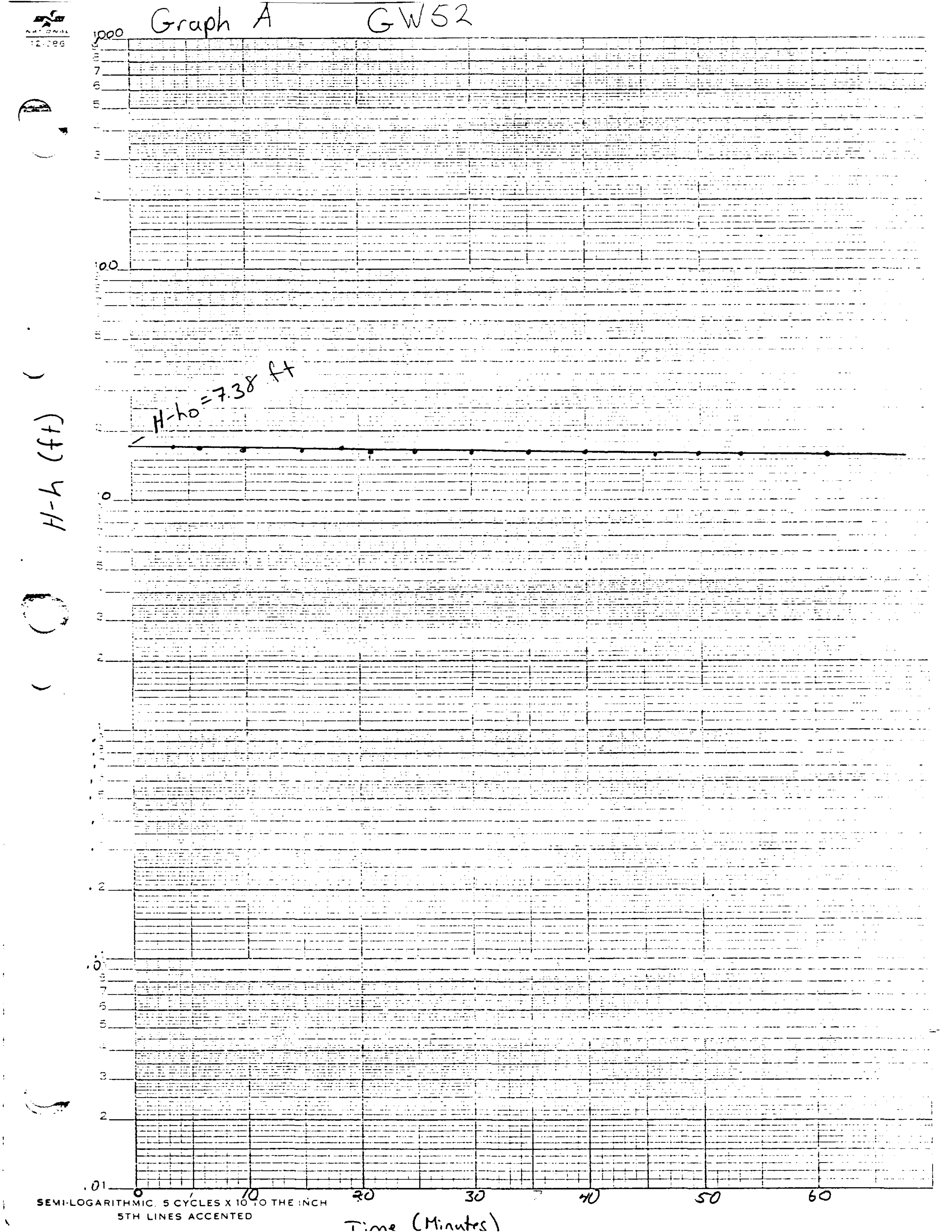
CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW52

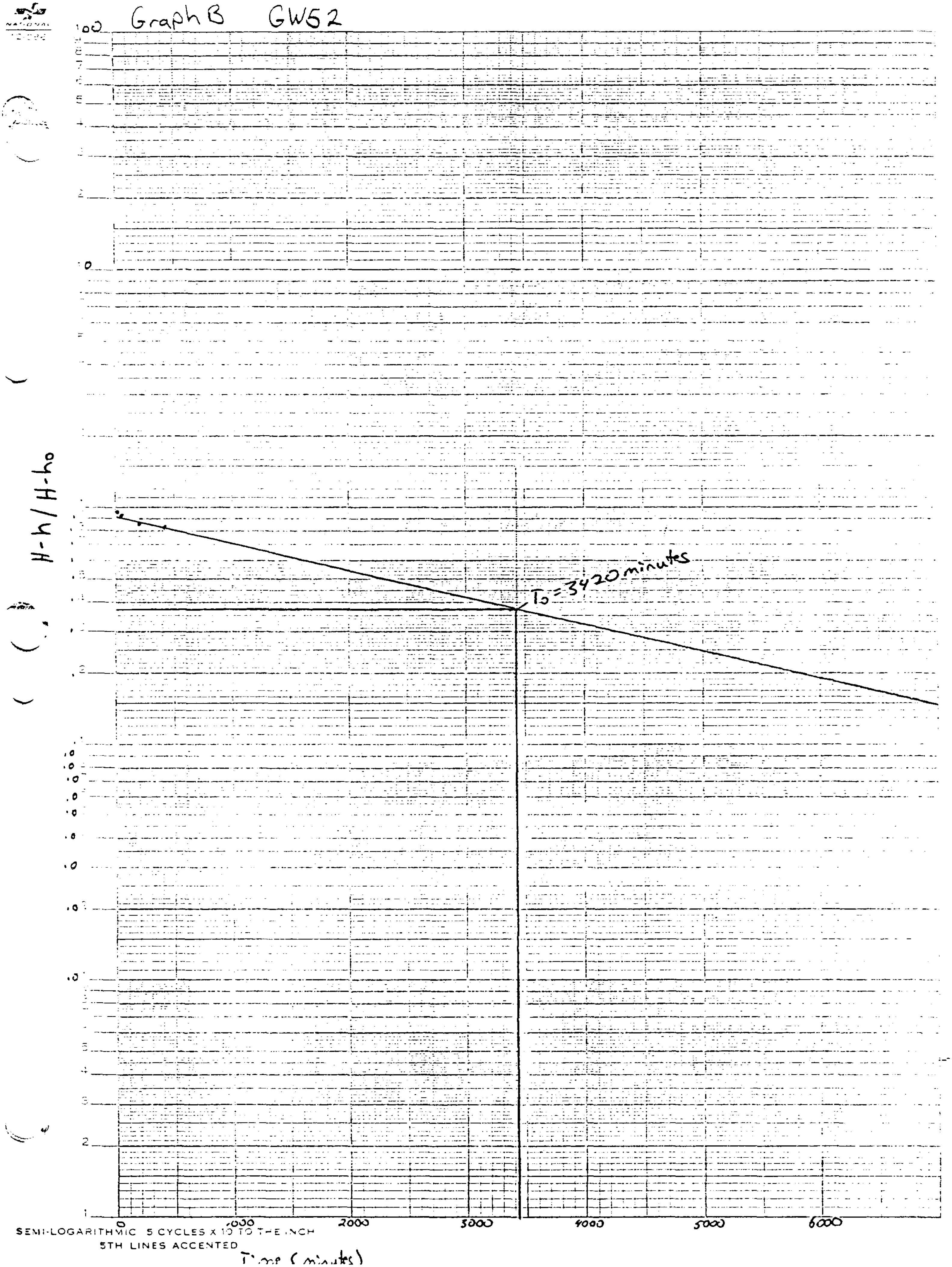
r	=	0.0833 ft
R	=	0.33 ft
L	=	17.38 ft
T_o	=	3420 minutes x 60 = 205,200 seconds
H	=	12.97 ft
H-ho	=	17.38 ft

$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\,L\,T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{17.38}{0.33}\right)}{2\,(17.38)\,(205{,}200)}$$

$$= 3.86 \times 10^{-9} \text{ ft/s} \times 6.46 \times 10^{5} = 0.0025 \text{ U.S. gal/day/ft}^2$$


Graph A GW52
1000
100
10
1
.1
.01
H-ho=7.38 ft
H-h (ft)
0
10
20
30
40
50
60
Time (Minutes)
SEMI-LOGARITHMIC, 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED



Graph B GW52
H-h / H-ho
To = 3420 minutes
0
1000
2000
3000
4000
5000
6000
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED
Time (minutes)

CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW53

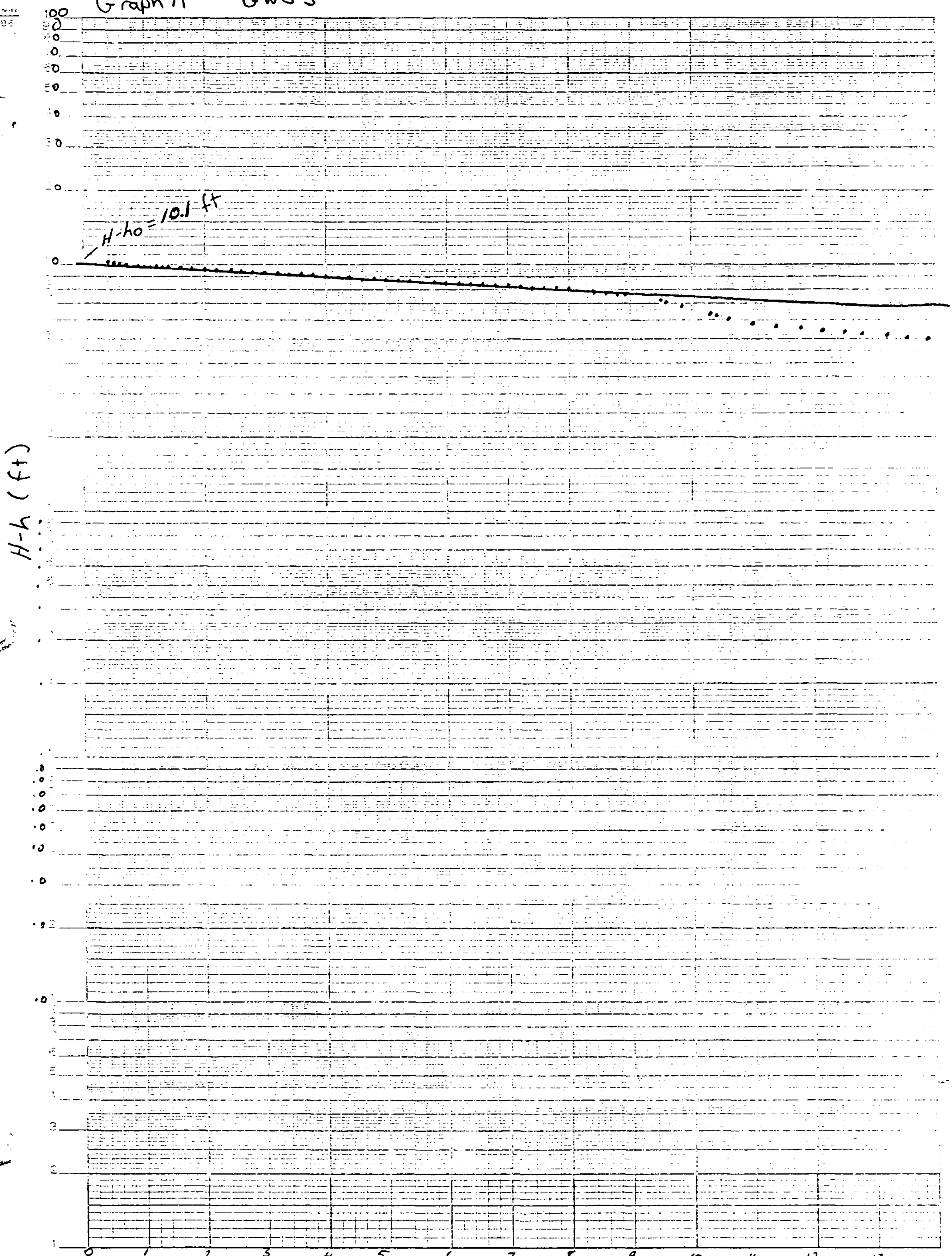
r	=	0.0833 ft
R	=	0.33 ft
L	=	11.86 ft
T_o	=	14.75 minutes x 10 = 885 seconds
H	=	5.9 ft
H-ho	=	10.1 ft

$$K = \frac{r^2 \ln \frac{L}{R}}{2 L T_o}$$

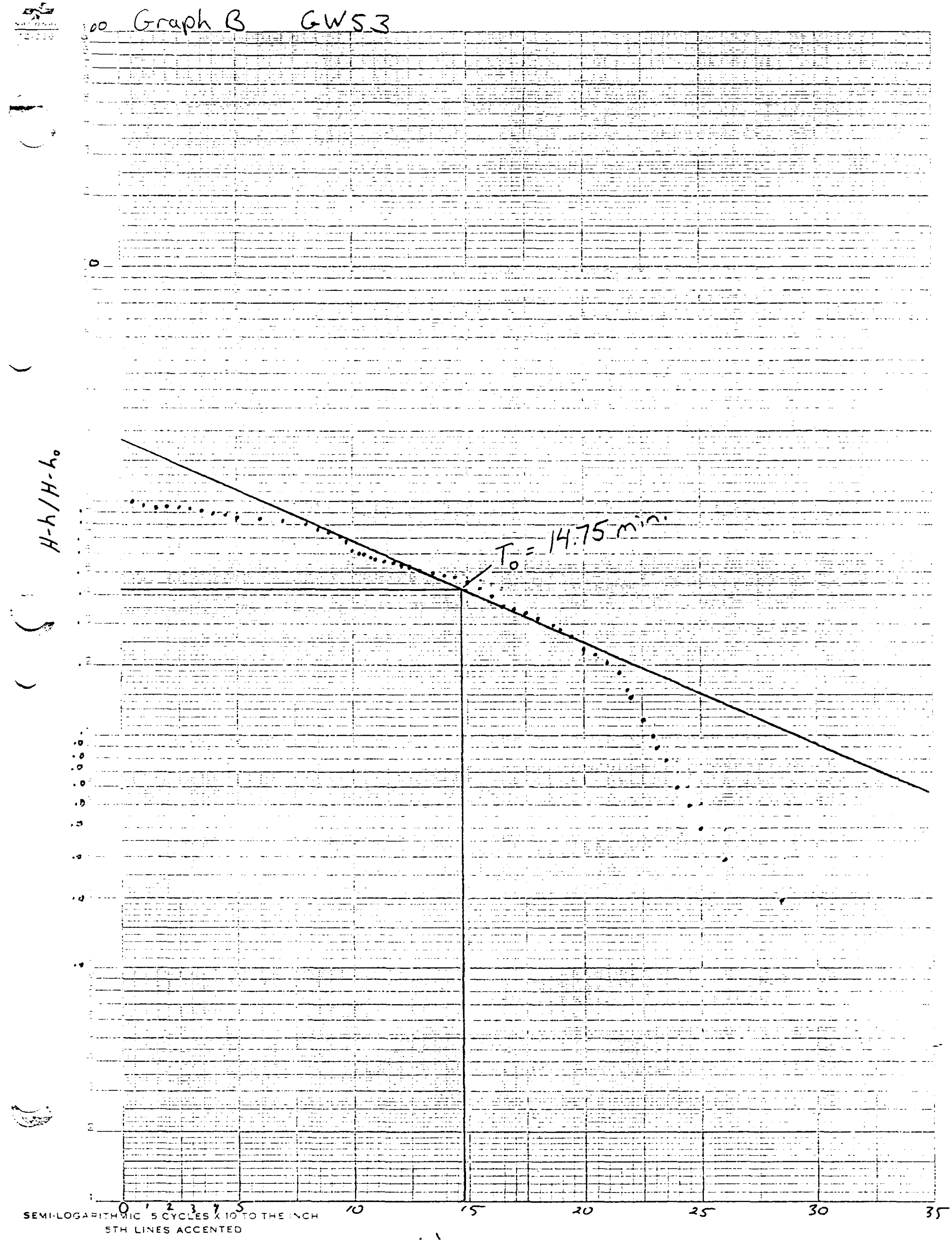
$$= \frac{(0.0833)^2 \ln \frac{11.86}{0.33}}{2 (11.86) (885)}$$

$$= 1.84 \times 10^{-6} \text{ ft/s} \times 6.46 \times 10^5 = 1.19 \text{ U.S. gal/day/ft}^2$$

Graph A GW53



SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED


Graph B GW53
H-h/H-h₀
T₀ = 14.75 min.
0 1 2 3 4 5 10 15 20 25 30 35
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW54

Using T_{oa}:

r	=	0.0833 ft
R	=	0.33 ft
L	=	4.57 ft
T_o	=	335 minutes x 60 = 20,100 seconds
H	=	21.76 ft
H-ho	=	4.57 ft

$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\,L\,T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{4.57}{0.33}\right)}{2\,(4.57)\,(20{,}100)}$$

$$= 9.9 \times 10^{-8} \text{ ft/s} \times 6.46 \times 10^5 = 0.064 \text{ U.S. gal/day/ft}^2$$

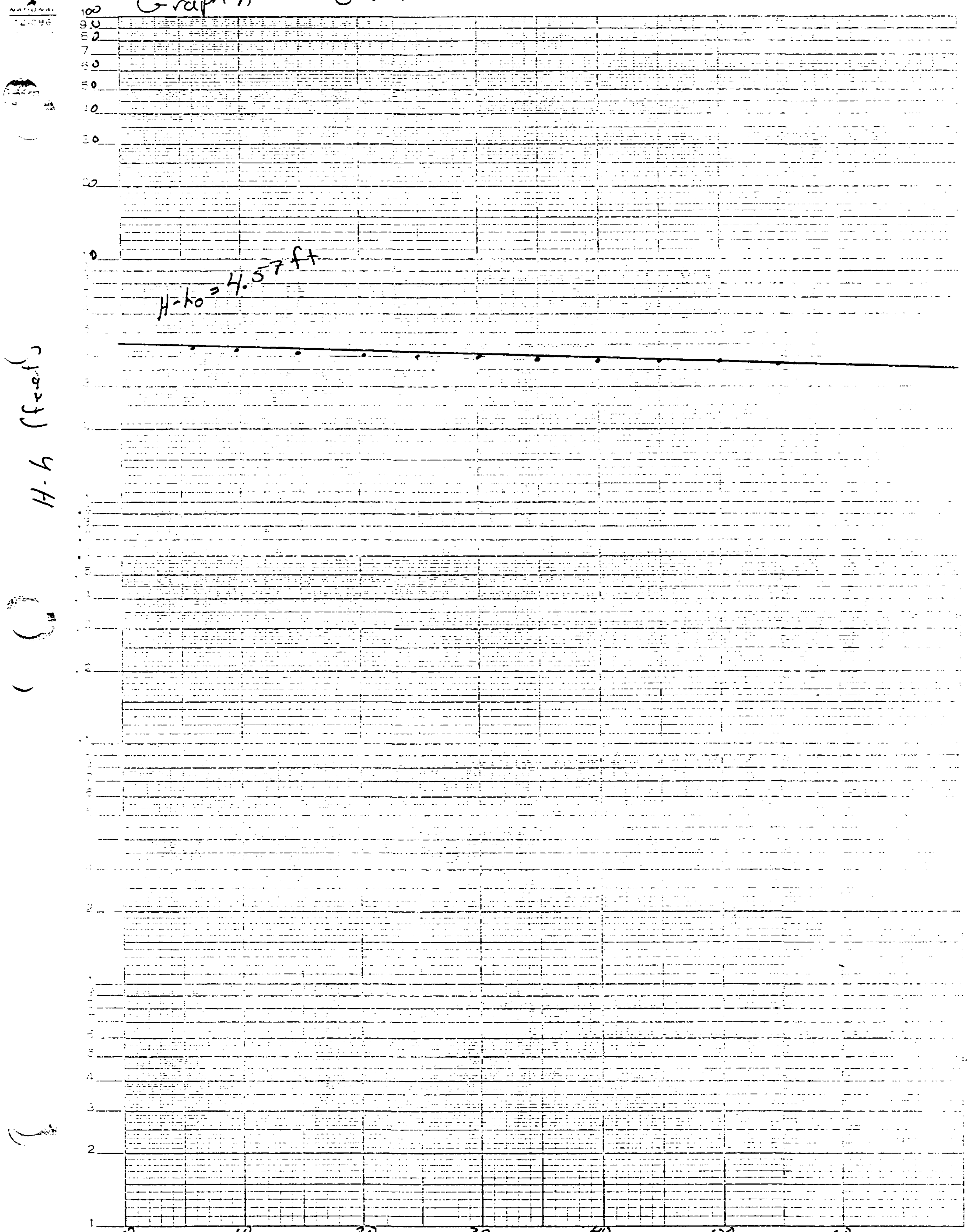
Using T_{ob}:

$$T_{ob} = 260 \text{ minutes} \times 60 = 15{,}600 \text{ seconds}$$

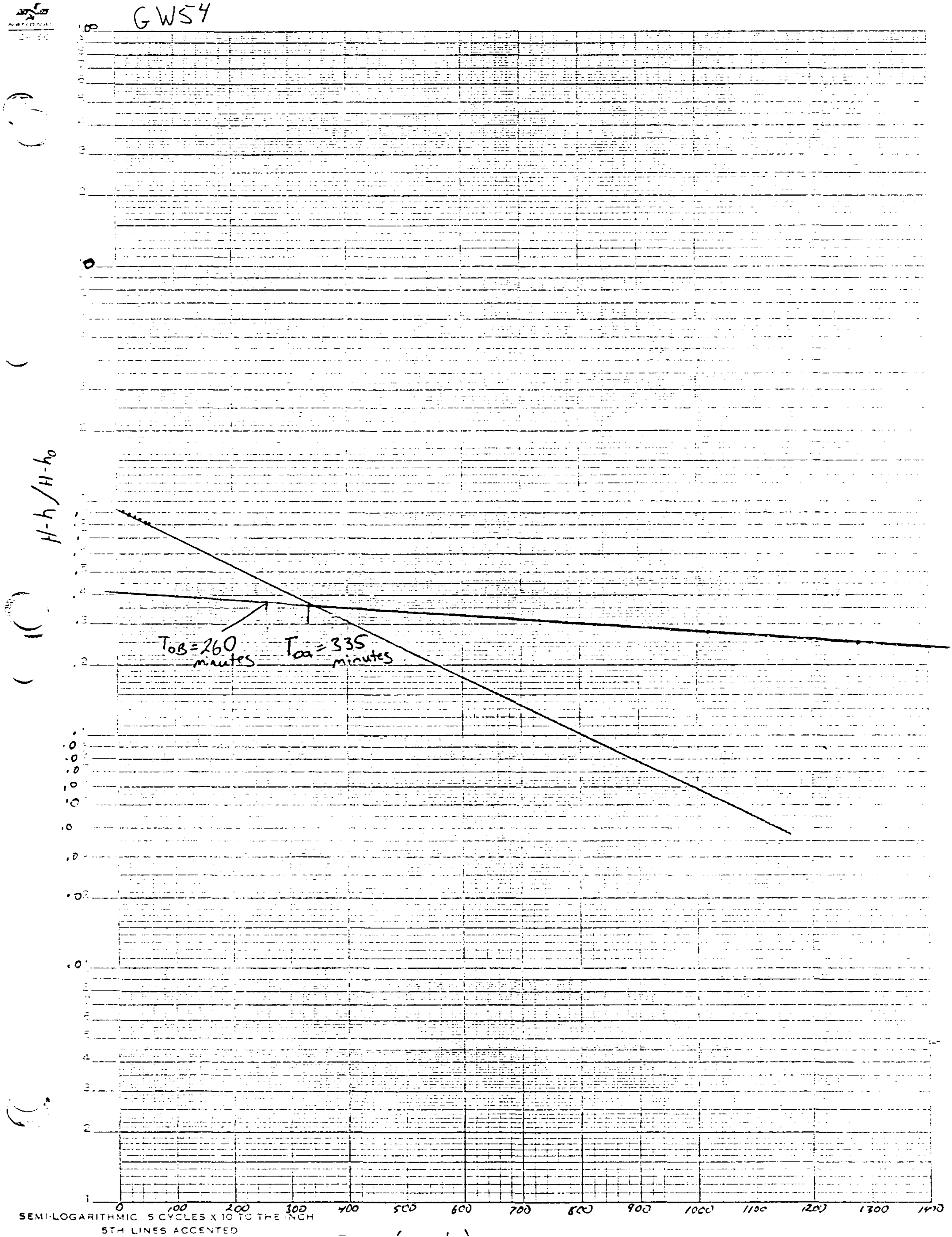
$$= \frac{(0.0833)^2 \ln \frac{4.57}{0.33}}{2\,(4.57)\,(15{,}600)}$$

$$= 1.28 \times 10^{-7} \times 6.46 \times 10^5 = 0.08 \text{ gal/day/ft}^2$$

Graph A GW54



SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED


GW54
H-h/H-ho
T_{oB}=260 minutes
T_{oa}=335 minutes
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW55

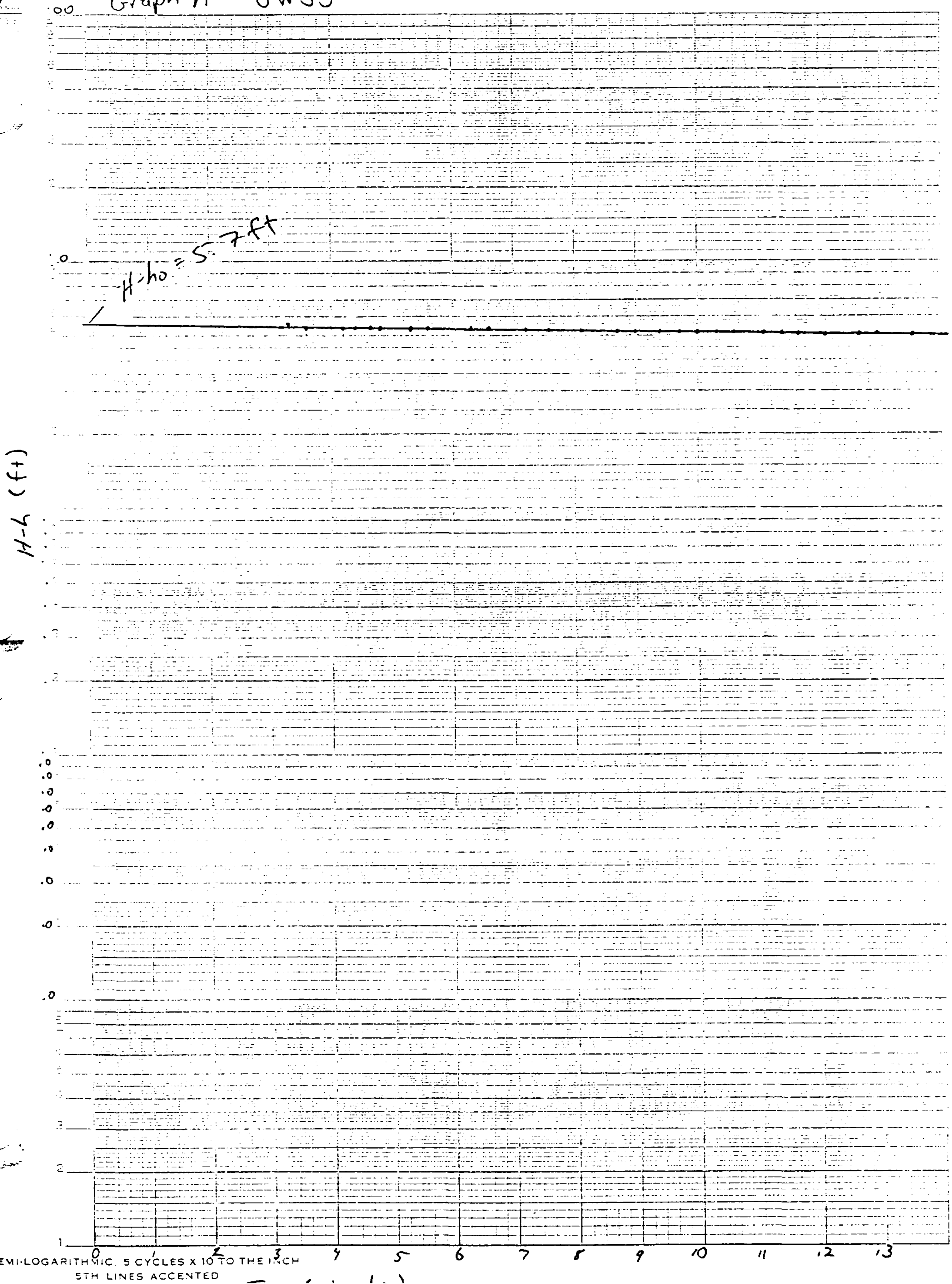
r	=	0.0833 ft
R	=	0.33 ft
L	=	5.7 ft
T_o	=	13,750 minutes = 1,005,000 seconds = 1.005×10^6 seconds
H	=	12.96 ft
H-ho	=	5.7 ft

$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\, L\, T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{5.7}{0.33}\right)}{2\,(5.7)\,(1.005 \times 10^6)}$$

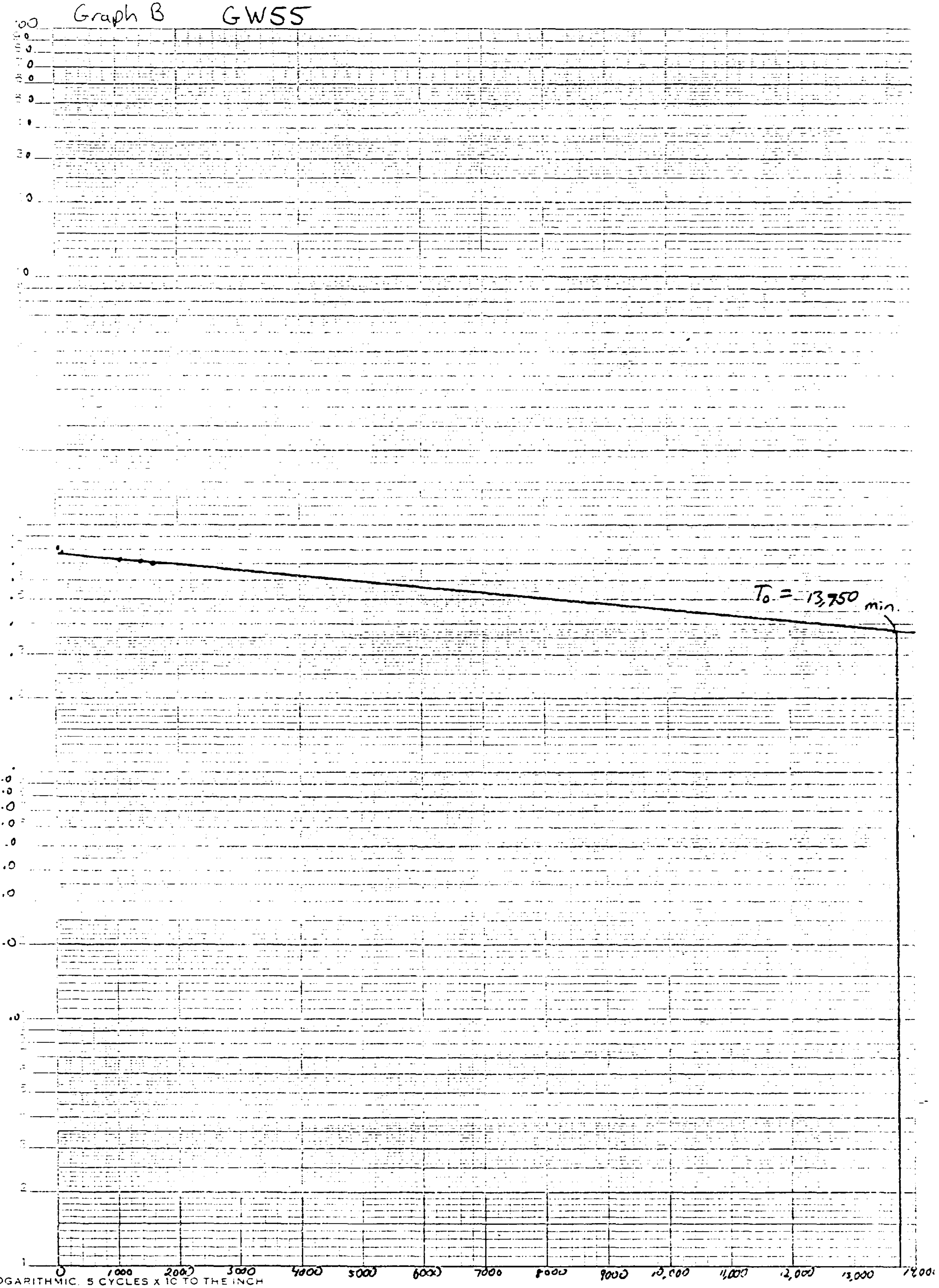
$$= 1.73 \times 10^{-9} \text{ ft/s} \times 6.46 \times 10^5 = 0.001 \text{ gal/day/ft}^2$$

Graph A GW55



100
10
H-ho = 5.7ft
H-h (ft)
2
1
0 1 2 3 4 5 6 7 8 9 10 11 12 13
SEMI-LOGARITHMIC, 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

Graph B GW55



SEMI-LOGARITHMIC. 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW56

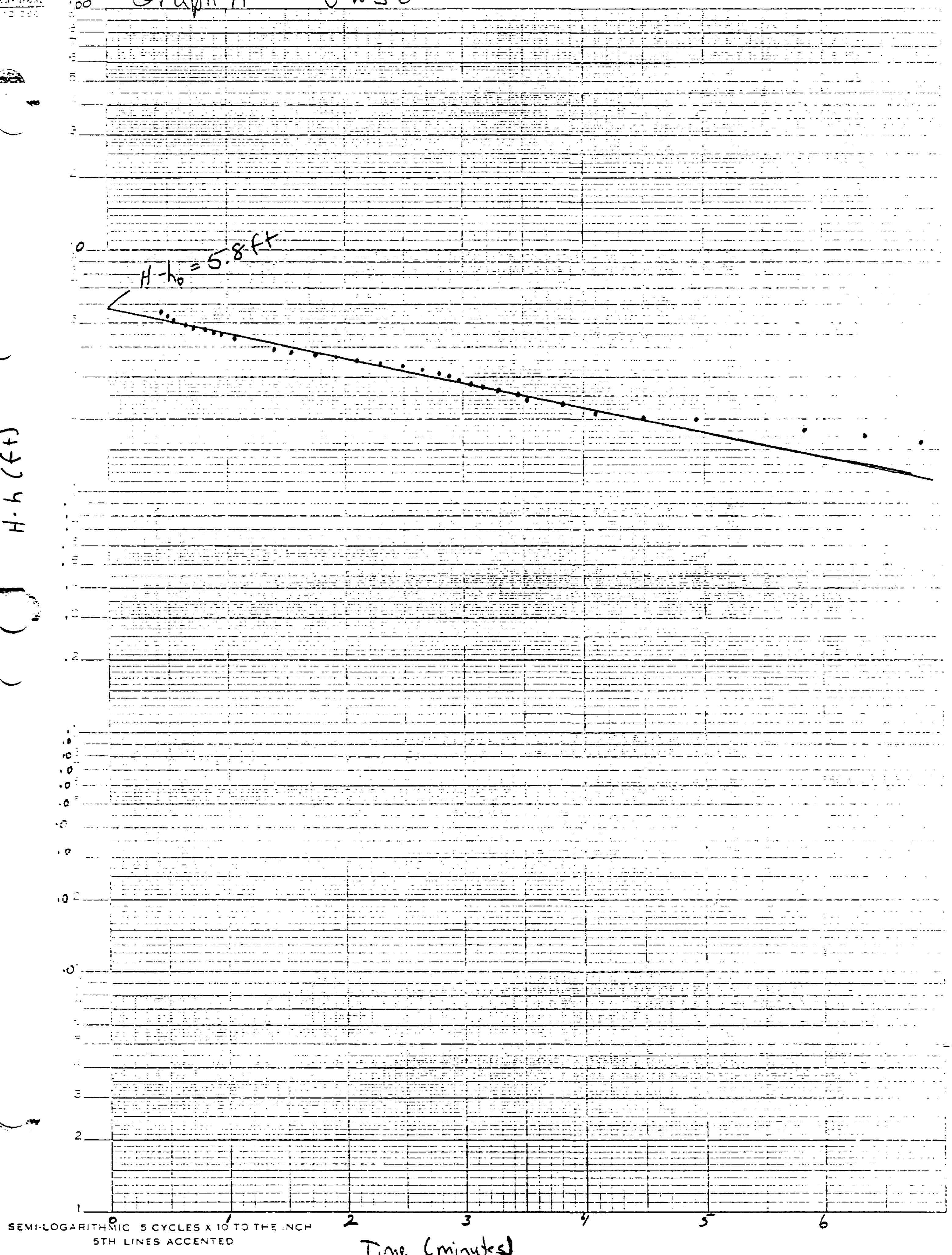
r	=	0.0833 ft
R	=	0.33 ft
L	=	8.105 ft
T_o	=	4.3 minutes x 60 = 258 seconds
H	=	5.675 ft
H-ho	=	5.8 ft

$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\,L\,T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{8.105}{0.33}\right)}{2\,(8.105)\,(258)}$$

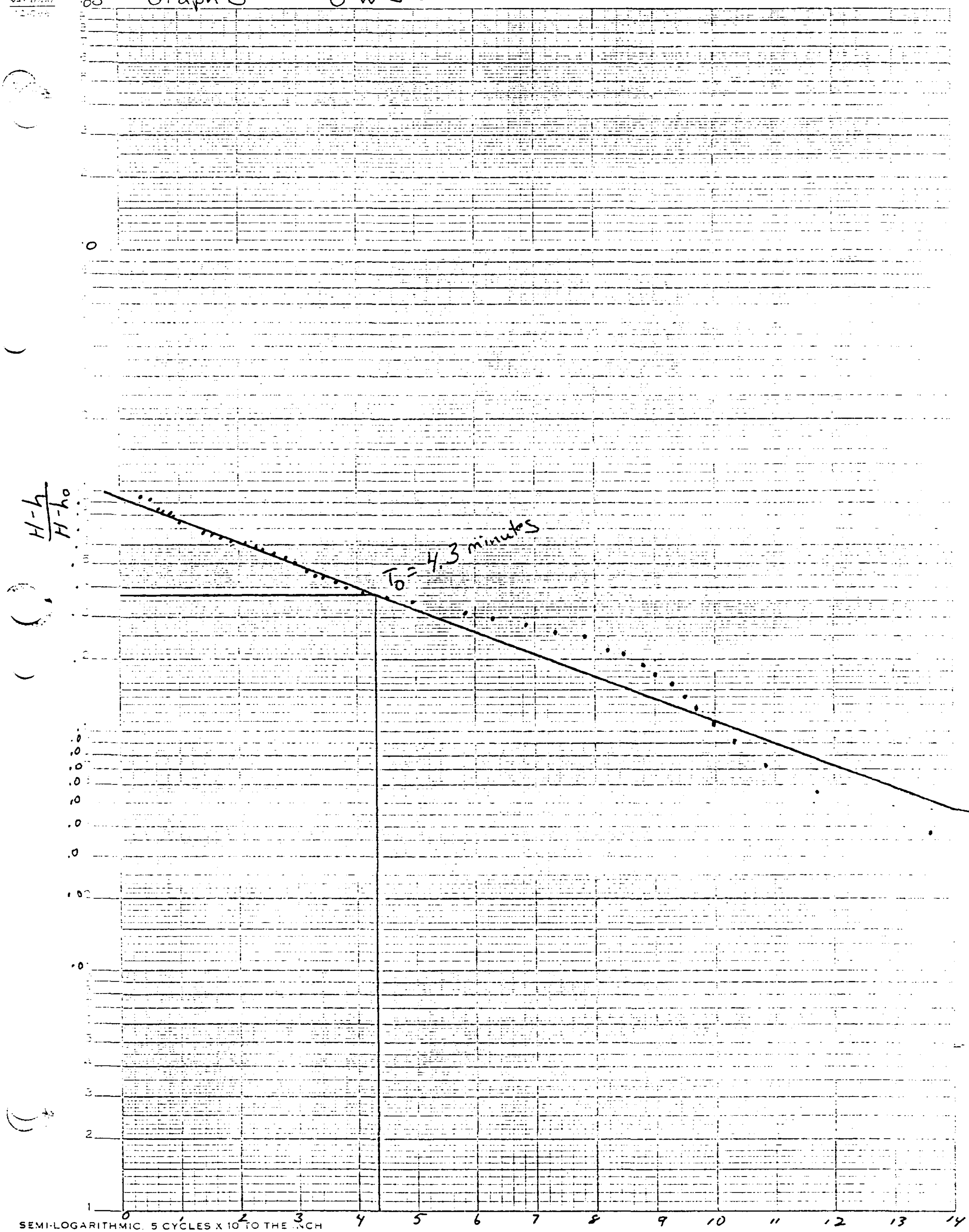
$$= 5.31 \times 10^{-6} \text{ ft/s} \times 6.46 \times 10^{5} = 3.43 \text{ U.S. gal/day/ft}^2$$

Graph A GWS6



$H-h_o = 5.8$ ft
H-h (ft)
Time (minutes)
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

Graph B GWS6



SEMI-LOGARITHMIC. 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

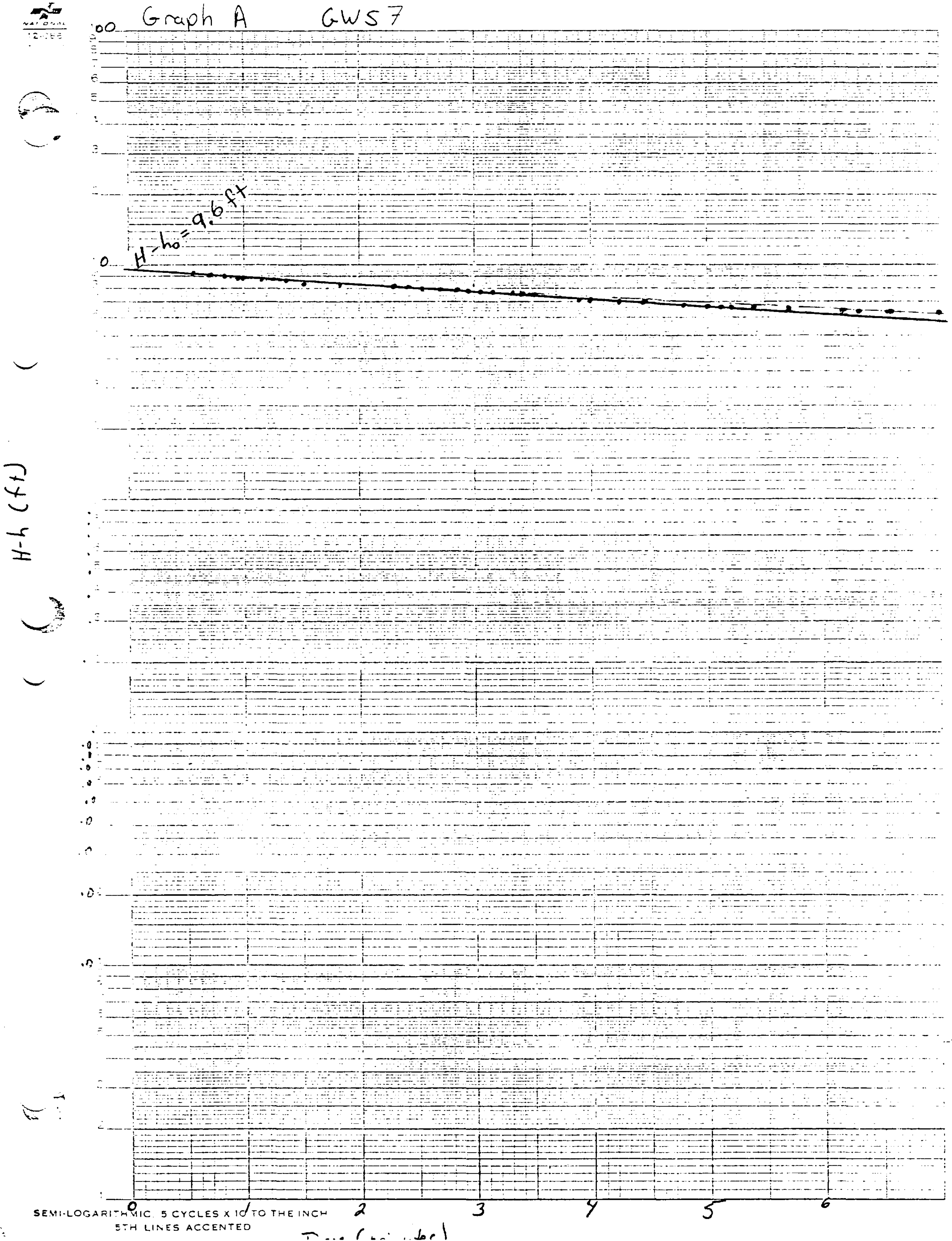
CALCULATION OF HYDRAULIC CONDUCTIVITY FOR GW57

r	=	0.0833 ft
R	=	0.33 ft
L	=	10.41 ft
T_o	=	20.8 minutes x 60 = 624.6 seconds
H	=	8.08 ft
H-ho	=	9.6

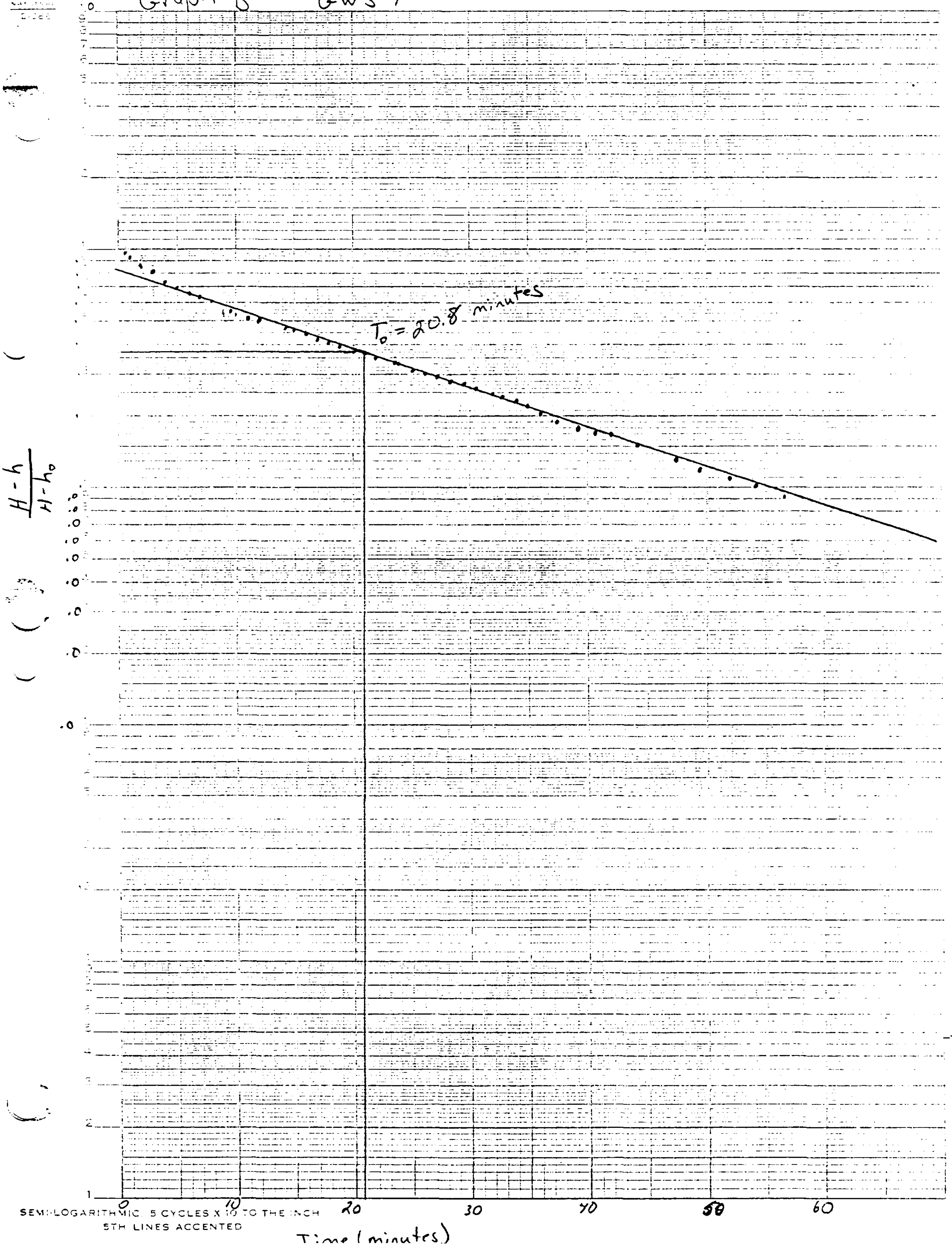
$$K = \frac{r^2 \ln\left(\frac{L}{R}\right)}{2\,L\,T_o}$$

$$= \frac{(0.0833)^2 \ln\left(\frac{10.41}{0.33}\right)}{2\,(10.41)\,(624.6)}$$

$$= 1.84 \times 10^{-6} \text{ ft/s} \times 6.46 \times 10^5 = 1.19 \text{ U.S. gal/day/ft}^2$$


Graph A GWS7
$H-h_o = 9.6$ ft
H-h (ft)
0
1
2
3
4
5
6
Time (minutes)
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

Graph B GWS 7


$T_0 = 20.8$ minutes
$\frac{H-h}{H-h_0}$
0
10
20
30
40
50
60
Time (minutes)
SEMI-LOGARITHMIC 5 CYCLES X 10 TO THE INCH
5TH LINES ACCENTED

VII

APPENDIX VII

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF ___
PROJECT NO. 72680.300

CLIENT Skinner Landfill
PROJECT West Chester, OH

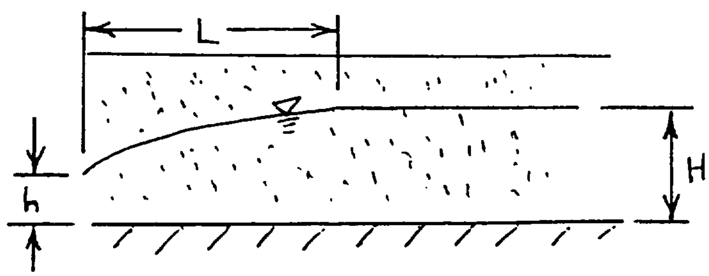
SUBJECT Groundwater Collection Trench Flow Calculation

Prepared By BER Date 1/10/95
Reviewed By ___ Date ___
Approved By ___ Date ___

Determine quantity of groundwater entering the Collection Trench -

Equation

Source: Construction Dewatering - J. Patrick Powers, 2nd Edition, John Wiley & Sons, Inc 1992 Table 6.1



$$\frac{Q}{x} = \frac{K(H^2 - h^2)}{2L}$$

x = Unit length of Trench, for flow from 2 sides, use Twice the indicated value

K = permeability

Equation for U.S. Units $\frac{Q}{x} = \frac{K(H^2 - h^2)}{2880\ L}$

Q = flow in gallons per minute
H, h = head in feet
K = gallons per day / square feet